DYNAMICS OF LAND USE IN FAST GROWTH AREAS

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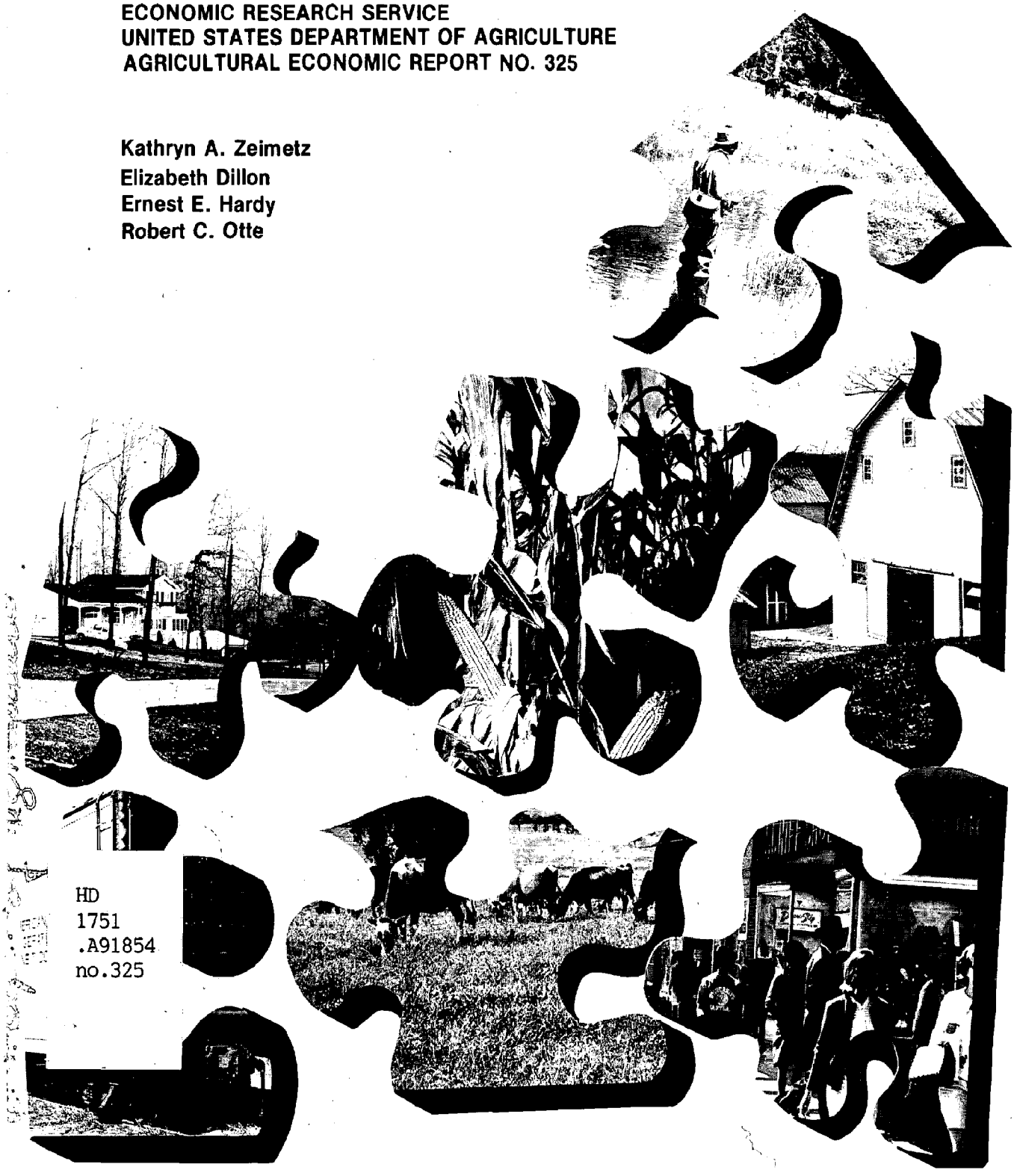

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ABSTRACT

Land use and land use changes between 1961 and 1970 were interpreted from Agricultural Stabilization and Conservation Service (ASCS) 1:20,000 scale photography for 53 rapid-growth counties. In these counties, which experienced about 20 percent of the total U.S. population increase between 1960 and 1970, urban land accounted for 16 percent of the area in 1970, up from 13 percent in 1961. Of land developed for urban use in the 53-county aggregate between 1961 and 1970, 35 percent had been cropland, 28 percent forest, and 33 percent open idle. Regionally, the amount of urban development on various types of rural land differed considerably. While total land in rural uses remained relatively the same over the period, shifts among rural uses were an important aspect of land use change. The average amount of land urbanized per person increase in population for the 53-county total was .173 acres. While this per capita ratio varied regionally, in all regions new urban development occurred at a higher density than had previous urban development.

Key Words: Land use change, Urban land, Idle land, Cropland, Rapid growth areas, Airphoto interpretation.

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HIGHLIGHTS

At the national level, urbanization has not greatly encroached upon the total supply of U.S. land used for crops. In a study of 53 counties, in which 20 percent of the 1960 to 1970 U.S. population increase occurred, urban uses in 1970 occupied only 16.4 percent of the total land area, up from about 13 percent in 1961.

About 770,000 acres were converted to urban uses in the 53 counties during the 9-year period. Of these, 35 percent had been cropland, 4 percent pasture, 28 percent forest, and 33 percent open idle (fig. 1).

MAJOR LAND USE SHIFTS, 1961-70, 53 URBANIZING COUNTIES
(Thousands of Acres)

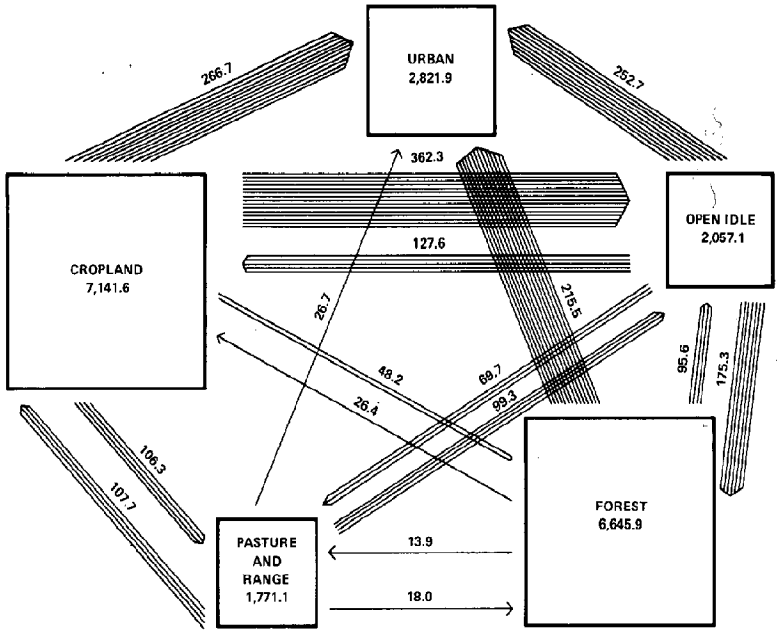

Figure 1

For all the counties, .173 acres of rural land were urbanized for each person increase in population.

There is considerable regional variation in the effects of urbanization on rural land uses and on the supply of land for food and fiber production. The proportion of new urban land coming from cropland ranged from 6 percent in the Florida counties to 70 percent in those in California. It was 50 percent in the Corn Belt area and 62 percent in the Great Lakes region. The amount of land urbanized per person increase in population also varied regionally from .097 acres in California to .481 acres in Florida. Generally, the per capita

urbanization rate was lower where urbanization took a high proportion of cropland and higher where urbanization used more forest and other noncropland.

Advancing urbanization has often meant intensification of use rather than expansion to rural areas. For example, residential land was converted to commercial-industrial-institutional as well as to transportation uses.

Cropland declined from about 33 percent of the total study area in 1961 to 30.4 percent in 1970. Only 49 percent of this net decline resulted directly from urbanization. More new cropland was developed, in fact, than was lost to urban development. Other factors accounted for more cropland decline than urban encroachment. These include abandonment of marginal cropland to pasture and diversion of cropland to open idle as changing technology makes farming of some land uneconomic.

In the study counties taken as a whole, acreage of land identified as open idle – nonforested land with no evidence of cropping, pasturage, or other activity – decreased by 104,000 acres. However, two areas, Florida and Colorado, accounted for most of the decrease. In those areas, substantial acreages of previously idle land were developed for cropland. The remainder of the counties, on net, showed an increase in acreage of idle land. Of the total additions to idle land, over 60 percent came from cropland. Of the land moving out of the idle category, 37 percent went to urban use and 30 percent went to agricultural use.

This study, documenting land use change by interpretation from aerial photography, shows that two other nonurban uses – pasture and range and forests – experienced only slight declines between 1961 and 1970.

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INTRODUCTION

The land on which man arranges his activities is a bounded resource and one subject to increasing demands.

As population pressure increases and as people strive for higher standards of life, more and more competition can be expected between land uses. This competition will favor more intensive land-use practices; and it will also lead to significant shifts in land use and to the subjugation and nonfulfillment of many land requirements. At the same time, it will probably bring additional controversies and conflicts of interest. In the final analysis, the arbitration and resolution of these conflicts by society will call for a larger measure of institutional and governmental control over land use practices.[1]

For land use controls to be rationally formulated and effectively applied, land use dynamics must be understood.

Land use change has been the focus of continuing appraisal by researchers. Bogue's 1956 historical study of land use in metropolitan areas concluded: "The spreading of cities is an unmistakable drain upon agricultural resources," and "within the metropolitan areas themselves, the processes of replacing land used for urban purposes has about reached a limit."[2] Concern about urban growth's drain on agricultural land has been echoed by others such as Griffin and Chatham in their investigation of Santa Clara County, California.[3] Another negative influence of urban development on agricultural land – idling more land than is actually developed for urban and other intensive uses – has been explored and various calculations have been made of ratios of land withdrawn from agriculture to land actually developed for other activities.[4] Such conclusions have contributed to alarm over loss of farmland to urban uses as articulated in the Citizen's Advisory Committee on Environmental Quality.[5]

Conversely, it has been argued that agriculture does not always suffer at the expense of urban development, that often such growth stimulates land reclamation and intensifies production.[6] That urbanization is but one influence in changing land uses, especially regarding agricultural land, has been pointed out by Hart. Other factors he discusses include changes in crops, technology, and government programs.[7]

This study documents and examines land use changes, thus augmenting comprehension of land use dynamics. As have many previous land use studies, this one focuses upon areas with rapidly growing population because " . . . urbanization does increase the pressure on land as a resource, and accentuates the need for planned

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[1] Raleigh Barlowe, *Land Resource Economics: The Economics of Real Property*, 2nd ed. (Englewood Cliffs, N.J.: Prentice Hall, Inc., 1972) p. 86.

[2] Donald J. Bogue, *Metropolitan Growth and the Conversion of Land to Nonagricultural Uses* (Oxford, Ohio, 1956) p. 19.

[3] Paul F. Griffin and Ronald L. Chatham, "Urban Impact on Agriculture in Santa Clara County, California," *Annals of the Association of American Geographers*, XLVIII (1958) pp. 195-208.

[4] Robert Sinclair, "Von Thünen and Urban Sprawl," *Annals of the Association of American Geographers*, LVII (1957) pp. 72-87; David J. Allee et al., *Toward the Year 1985: The Conversion of Land to Urban Use in New York State* (Special Cornell Series No. 8, Cornell Univ., 1970).

[5] Citizen's Advisory Committee on Environmental Quality, *Report to the President and to the Council on Environmental Quality*, Dec. 1974.

[6] Mason Gaffney, "Containment Policies for Urban Sprawl," in *Approaches to the Study of Urbanization*, ed. by Richard L. Stauber (Univ. of Kansas, 1964); Curtis C. Harris, Jr. and David J. Allee, *Urbanization and its Effects on Agriculture in Sacramento County, California I. Urban Growth and Agricultural Land Use* (Giannini Found. of Agr. Econ., Res. Rpt. 268, 1968).

[7] John Fraser Hart, "Loss and Abandonment of Cleared Farm Land in the Eastern United States," *Annals of the Association of American Geographers*, LVIII (1968) pp. 417-440.

controls and for vigorous programs of land conservation and use."[8] Land use change in response to this pressure should be especially apparent in areas where the population is growing very rapidly.

Study Area

Between 1960 and 1970, 129 U.S. counties each experienced an absolute population increase exceeding 20,000 and a percentage population increase exceeding 30 percent. Of these, 53 also had recent Agricultural Stabilization and Conservation Service (ASCS) aerial photography of the entire county for two points in time with approximately a 10-year interval. (Optimally, photography for each county will be for 1960 and 1970. However, the intervals vary because ASCS rephotographs areas only when significant changes in farm boundaries and road systems have occurred.) It is for these 53 counties that land use change was documented (fig. 2 and app. A).

This selection process introduced some biases. The use of both absolute and percentage limits on population change was selective for peripheral counties in expanding urban areas. Limiting the study to counties with complete ASCS photography resulted in inclusion of relatively few agriculturally unimportant areas, since ASCS obtains photography primarily to monitor field patterns of crops under various Federal farm programs. In many large Western counties, where cropland is concentrated within limited irrigated areas, ASCS obtains photography of only cropped areas. Such counties were excluded from this study because only part of the land use change in each county could be accounted for.

Procedure

Land use and land use change were interpreted from a systematic sample of 1:20,000 scale ASCS contact prints selected to account for at least 10 percent of the same area in each county in both time periods. Within each print, a sample of random points was selected at the rate of 20 points per square mile. Each sample point was located on both the earlier and later photographs and the interpreted land use recorded in the appropriate cell of the land use transition matrix (see app. B and C). This procedure was followed for each set of contact prints within each county. For each county, a point had a specific acre equivalent obtained by dividing the county's area, provided by census publications, by the total number of points interpreted for that county. This value was multiplied by the number of points in each cell of the matrix. The sampling rate for all 53 counties averaged three points per square mile.

Twelve land use categories were distinguished: (1) cropland, (2) pasture and range, (3) open idle, (4) farmsteads, (5) forest, (6) residential, (7) urban idle, (8) transportation, (9) recreation, (10) commercial-industrial-institutional, (11) water bodies over 40 acres, and (12) miscellaneous.

Categories interpreted from airphotos are not always mutually exclusive or accurately distinguishable. When using airphoto interpretation, cover is a surrogate for use. The resulting complications of this are discussed at greater length in the text and App. B. As each point was described by both an earlier and later use, there were 144 possible "from-to" categories of land use change. Data derived in this manner included not only net land uses in each category for each time period, but also detailed movements of land between categories.

To study constancy over time of the observed land use changes, four of the original 53 counties were subjected to the same sampling procedure for an earlier time period. These counties – Dupage, Ill.; Prince Georges, Md.; Clay, Mo.; and Tarrant, Tex. – also had experienced population increase of at least 30 percent and 20,000 persons between 1950 and 1960. Land use change was also documented for Somerset County, Pa., which experienced a net population decrease from 1960 to 1970. Somerset data were analyzed separately.

Data were summarized by adding acreage figures derived individually for each study county. Actual years of photography and the length of interval between each set varied by county. The average years of photography for the earlier and later time periods were 1961 and 1970, respectively. For simplicity, these years will be used to designate all earlier and later sets of land use data (app. B).

County data were grouped two ways. Twelve categories resulted when the purpose was to group spatially related counties exhibiting similar land use patterns (table 1). Jackson County, Miss., was not included in any set because its land use pattern differed markedly from geographically proximate study counties. These twelve groups represent a compromise between delineation by land resource regions and delimitation by the land use profiles shown by the airphoto interpretation.[9] Six categories were used to group counties by orientation to an urban complex (table 2). To this end, counties were sorted as to whether in 1970 they were SMSA[10] counties and if they included census-defined

[8] Luther Gulick, "The City's Challenge in Resource Use," in *Perspectives on Conservation,* ed. by Henry Jarrett (Baltimore: The Johns Hopkins Press, 1958) p. 128.

[9] Morris E. Austin, *Land Resource Regions and Major Land Resource Areas of the United States* (U.S. Dept. Agr., Soil Conserv. Serv., AH 296, 1965).

[10] An SMSA (Standard Metropolitan Statistical Area) is a county or group of contiguous counties that contains at least one city of at least 50,000 persons or twin cities with a combined population of 50,000 or more. In addition, counties contiguous to the above are included in an SMSA if they are essentially metropolitan in character and are socially and economically integrated with the central city.

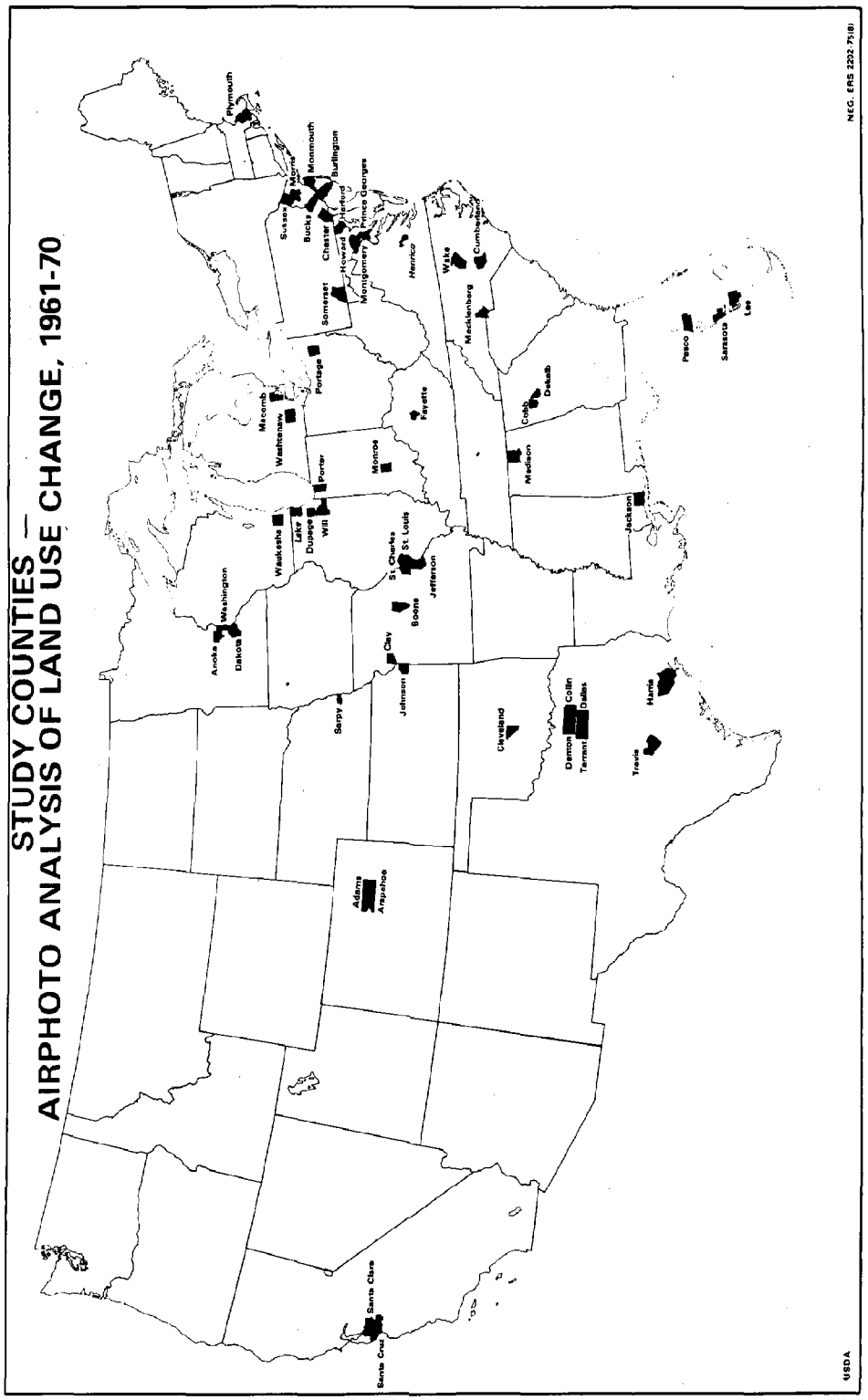
STUDY COUNTIES —
AIRPHOTO ANALYSIS OF LAND USE CHANGE, 1961-70
Plymouth
Sussex
Monmouth
Burlington
Bucks
Chester
Howard
Montgomery
Prince Georges
Somerset
Henrico
Wake
Cumberland
Mecklenburg
Pasco
Sarasota
Lee
Macomb
Washtenaw
Portage
Fayette
Monroe
Porter
Cobb
DeKalb
Madison
Jackson
Lake
Dupage
Will
Waukesha
St. Charles
St. Louis
Jefferson
Boone
Washington
Anoka
Dakota
Clay
Johnson
Sarpy
Cleveland
Collin
Dallas
Denton
Tarrant
Harris
Travis
Adams
Arapahoe
Santa Cruz
Santa Cruz
USDA
NEG. ERS 2202-75(8)

Figure 2

Table 1 – Regional groupings of 53 sample counties

North East	Florida Gulf	South Central Prairie-Woodland Fringe
Plymouth, Mass.	Lee, Fla.	Cleveland, Okla.
Burlington, N.J.	Pasco, Fla.	Harris, Tex.
Monmouth, N.J.	Sarasota, Fla.	Travis, Tex.
Morris, N.J.		
Sussex, N.J.		
Bucks, Pa.	Great Lakes	Texas Prairie
Chester, Pa.		
	Macomb, Mich.	Collin, Tex.
	Washtenaw, Mich.	Dallas, Tex.
Middle Atlantic	Waukesha, Wis.	Denton, Tex.
	Anoka, Minn.	Tarrant, Tex.
Harford, Md.	Dakota, Minn.	
Howard, Md.	Washington, Minn.	
Montgomery, Md.		Colorado
Prince Georges, Md.		
Henrico, Va.	Corn Belt	
		Adams, Colo.
	Dupage, Ill.	Arapahoe, Colo.
Piedmont	Lake, Ill.	
	Will, Ill.	
Cumberland, N.C.	Porter, Ind.	California
Mecklenburg, N.C.	Boone, Mo.	
Wake, N.C.	Clay, Mo.	Santa Clara, Calif.
Cobb, Ga.	Jefferson, Mo.	Santa Cruz, Calif.
Dekalb, Ga.	St. Charles, Mo.	
	St. Louis, Mo.	
	Sarpy, Nebr.	Mississippi
Appalachian Fringe	Johnson, Kans.	
		Jackson, Miss.
Portage, Ohio		
Monroe, Ind.		
Fayette, Ky.		
Madison, Ala.		

urbanized areas and/or SMSA central cities. Results of this grouping reinforced the earlier observation that the selection was weighted toward peripheral counties in large urban areas. Twenty-eight were SMSA counties which included urbanized areas but no part of the central SMSA city.

A fuller description of the methodology is included in App. B. This appendix also includes detailed descriptions of land use categories as well as a discussion of verification of the sampling procedure and its implications for possible further applications.

Study Area Characteristics

Total area of the study counties was 34,000 square miles (21,765,000 acres). Size varied from 234 to 1,766 square miles and averaged 642 square miles. Population in the study counties rose from 11,145,000 in 1960 to 16,310,000 in 1970, an increase of 46.3 percent (table 3). Twenty percent of the population increase between 1960 and 1970 in the 48 coterminous States occurred within these counties. They accounted for 1.1 percent of the total area and 8.0 percent of the population of the 48 coterminous States in 1970. Their share of population had increased from 4.6 percent in 1950 and 6.2 percent in 1960.

The proportion of the population in the study counties that was urban was higher than that of the United States; urbanization increased more rapidly there than for the entire Nation (table 3). In 1970, density in the 53 counties ranged from 80 to 1,906 persons per square mile, averaging 478 persons per square mile. This was seven times greater than the average density of the 48 States.

Much concern over land use in rapidly urbanizing counties centers on impacts of growth upon the agricultural base. The number of farms and market value of all agricultural products sold in these counties are proportionally greater than their area alone would indicate, although the proportional difference has narrowed since 1959 (table 4). In 1969, the 53 counties accounted for 1.0 percent of U.S. land in farms, slightly less than their proportion of the 48-State area (1.1

percent). In 1959, the proportion of U.S. farmland in the study counties equalled the percentage of the national area they represented. These study counties accounted for 1.9 percent of the total number of farms in 1969; thus average farm size was smaller than the U.S. average. However, the value of land and buildings per acre was three times the U.S. average. In 1969, the market value of all agricultural products sold was 2.0 percent of the amount of the 48 coterminous States, down from 2.3 percent in 1959.

Table 2 – Grouping of 53 study counties based on urban orientation

I. Non-SMSA counties

Santa Cruz, Calif.
Lee, Fla.
Pasco, Fla.
Sarasota, Fla.
Monroe, Ind.
Sussex, N.J.

II. Non-SMSA county identified as part of an urbanized area

Monmouth, N.J.

III. SMSA counties including no urbanized area

Harford, Md.
Jefferson, Mo.

IV. SMSA counties containing parts of urbanized areas but none of the central SMSA city

Adams, Colo.	Jackson, Miss.
Arapahoe, Colo.	St. Charles, Mo.
Cobb, Ga.	St. Louis, Mo.
Lake, Ill.	Sarpy, Nebr.
Will, Ill.	Burlington, N.J.
Porter, Ind.	Morris, N.J.
Johnson, Kans.	Portage, Ohio
Howard, Md.	Bucks, Pa.
Montgomery, Md.	Chester, Pa.
Prince Georges, Md.	Collins, Tex.
Macomb, Mich.	Dallas, Tex.
Anoka, Minn.	Denton, Tex.
Dakota, Minn.	Henrico, Va.
Washington, Minn.	Waukesha, Wis.

V. SMSA counties which include parts of urbanized areas and part of the central SMSA city

Dekalb, Ga.	Cleveland, Okla.
Dupage, Ill.	Harris, Tex.
Clay, Mo.	Tarrant, Tex.

VI. SMSA counties which include the entire SMSA central city

Madison, Ala.	Boone, Mo.
Santa Clara, Calif.	Cumberland, N.C.
Fayette, Ky.	Mecklenburg, N.C.
Plymouth, Mass.	Wake, N.C.
Washtenaw, Mich.	Travis, Tex.

Table 3 – Population characteristics in the 53 study counties

Item	Study counties	48 coterminous States
Population:	*Thousands*	
1970	16,310	202,143
1960	11,145	178,464
1950	6,990	150,697
Change in population:	*Percent*	
1960-70	46.2	13.3
1950-60	59.4	18.4
Urban population:		
1970	85.5	73.5
1960	80.6	69.9
1950	70.4	64.0
Population density:	*Persons per square mile*	
1970	480	67
1960	328	59
1950	206	50

Land Use Profiles

The overall land use picture for the 53 combined counties did not change dramatically between the two points in time (table 5). Ranking uses by magnitude resulted in the same order for both 1961 and 1970. Cropland occupied the most area in both time periods. Since 1961, it experienced a net decline of over 500,000 acres, equalling 2.5 percent of the total study area. The second largest land use was forest land which accounted for about 30 percent of the area in both time periods. Urban uses made up the third largest areal proportion. They showed the largest net acreage change between the two periods, increasing slightly over 750,000 acres. This was equal to 3.5 percent of the total study area.

Open idle land experienced a net decline between the two time periods. This was contrary to expectations and observations of other researchers.[11] This points up the difficulty in drawing inference from net land use change data. A closer examination of movement of land into and out of the idle category in a later section of this report will show that population increase and urbanization are associated with land idling. It will also show that cropland development can and does occur near urban areas.

Considering regional groups, the pattern of land use and net change is more complicated. Regionally, the

[11] See footnotes 5 and 6.

Table 4 – Agricultural characteristics of the 53 study counties compared to the 48 coterminous States

Item	Study counties total	48-State total	Study counties as percent of 48-State total
1959			
Percent of total land in farms	59.6	58.9	
Number of farms *(thousands)*	73.4	3,703.9	2.0
Land in farms *(million acres)*	12.7	1,120.2	1.1
Average farm size *(acres)*	172.6	302.4	
Value of land and buildings *(million dollars)*	4,143.0	128,988.0	3.2
Average per acre *(dollars)*	325.0	115.0	
Average per farm *(dollars)*	56,450.0	34,860.0	
Market value of all agricultural products sold *(million dollars)*	710.0	30,337.0	2.3
1969			
Percent of total land in farms	51.2	55.7	
Number of farms *(thousands)*	52.8	2,726.0	1.9
Land in farms *(million acres)*	10.9	1,059.7	1.0
Average farm size *(acres)*	206.1	388.7	
Value of land and buildings *(million dollars)*	6,792.0	206,119.0	3.3
Average per acre *(dollars)*	625.0	195.0	
Average per farm *(dollars)*	128,150.0	75,600.0	
Market value of all agricultural products sold *(million dollars)*	893.0	45,316.0	2.0

Source: U.S. censuses of agriculture, 1959 and 1969.

relative importance of different land uses varies due to physical factors such as climate, topography, and soils which affect the agricultural-nonagricultural land mix. The relative importance of urban versus nonurban uses among the various groups is influenced not only by the characteristics and land use requirements of the population, but also by the range in areal size of the counties. Finally, land use and land use change varies as cultural and technological changes differentially affect areas.

The proportion of area devoted to cropland at the beginning of the period ranged from 54.6 percent in the Great Lakes group to 10.0 percent in the three Florida counties. This range narrowed by 1970. While the Great Lakes still has the largest area proportion in cropland, California replaced Florida as the low group. In only two regions, the Gulf and Colorado counties, did cropland experience a net increase.

Percent of open idle land varied from 28.7 in the Florida group to 3.3 in the California counties in 1961 and from 20.9 to 4.2 percent for the same groups in the later sample. While net change in idle for all 53 counties grouped together was negative, an increase occurred in six groups – the Northeast, Corn Belt, Great Lakes, South Central Prairie/Woodland Fringe, Texas Prairie, and California. This increase in idle land occurred in some of the agriculturally more important areas.

Regionally, forest showed the largest range in proportion of land use, varying in both periods from over 55 percent in the Piedmont counties to less than 1 percent in the Colorado counties. In only three of the regional groups – Appalachian Fringe, Florida Gulf, and Corn Belt – did forest land show a net increase.

Simple examination of land uses and net changes in major use for the 53 counties for two points in time suggests that land use was relatively static. The dynamism of land use change is better appreciated if specific changes among particular uses are examined. To best grasp the intricacy and magnitude of land use shifts, it is necessary to document and study the detailed shifts among the various uses. Land use shifts among the 12 categories of land use for each of the 53 counties were summarized in land use transition matrices, included in App. C. The dynamics and fluidity of change within each particular use are examined as are patterns of change evidenced by the different groups.

Table 5 – Land use in 53 study counties, by regions, 1961 and 1970

Land use and year[1]	North-east	Middle Atlantic	Piedmont	Appalachian Fringe	Florida Gulf	Jackson County, Miss.	Corn Belt	Great Lakes	South Central Prairie/ Woodland Fringe	Texas Prairie	Colorado	California	53-county total
	Percent												
Cropland													
1961	23.2	28.1	18.1	37.9	10.0	2.7	48.1	54.6	24.0	42.1	47.0	16.3	32.9
1970	20.4	24.0	14.0	35.0	14.2	2.7	46.3	50.1	20.8	37.6	47.5	12.8	30.4
Pasture and range													
1961	1.0	2.9	.4	4.7	8.1	.2	3.3	2.0	19.1	19.5	22.5	16.7	8.1
1970	.8	2.6	.4	4.3	7.1	.2	2.7	1.7	17.9	19.8	23.6	16.5	7.8
Farmsteads													
1961	.5	1.0	.4	1.3	.2	–	1.4	1.7	.7	1.1	.6	.4	.9
1970	.5	1.0	.4	1.3	.4	–	1.4	1.7	.7	1.0	.6	.3	.9
Open idle													
1961	7.7	6.7	7.4	7.1	28.7	14.7	6.7	8.4	8.0	6.3	18.7	3.8	9.5
1970	8.4	6.6	5.3	6.3	20.9	13.5	6.8	10.9	9.4	6.9	14.7	4.2	9.0
Forest													
1961	46.8	43.4	57.9	35.0	26.6	72.4	21.7	18.3	28.5	8.4	.7	51.3	30.5
1970	45.4	43.1	56.7	35.6	28.2	71.3	21.8	17.9	26.8	7.5	.6	51.2	30.1
Urban													
1961	15.9	15.7	13.6	11.8	4.7	4.2	14.8	11.0	16.0	17.7	6.1	8.1	12.9
1970	19.4	20.5	19.7	14.5	8.9	7.0	17.0	13.6	20.0	21.3	8.8	11.2	16.4
Residential													
1961	9.0	8.8	6.0	5.9	2.1	2.3	7.5	4.9	8.9	9.5	1.4	4.4	6.6
1970	11.1	12.2	10.1	7.5	5.0	4.1	8.9	6.0	12.1	11.3	2.9	6.3	8.8
Urban idle													
1961	.2	.2	.2	.2	.1	.1	.6	.2	.6	1.1	.1	.2	.4
1970	.1	.1	.2	.1	–	–	.4	.1	.3	.9	.1	.1	.3
Transportation													
1961	3.9	3.8	5.2	3.3	2.1	1.2	4.1	3.7	3.4	4.0	2.9	1.9	3.6
1970	4.3	4.4	6.0	3.5	2.8	1.7	4.3	4.4	3.6	5.1	3.4	2.2	4.1
Recreation													
1961	.6	.9	3.6	.5	.1	.2	.5	1.1	.5	.4	.2	.6	.5
1970	.7	1.1	5.3	.7	.4	.2	.5	1.3	.6	.6	.4	.8	.7
Commercial-industrial-institutional													
1961	2.2	2.1	1.8	1.9	.4	.4	2.2	1.1	2.6	2.3	1.5	.9	1.8
1970	3.1	2.8	3.0	2.6	.6	1.0	2.9	1.8	3.4	3.3	2.0	1.9	2.6
Water bodies more than 40 acres													
1961	3.3	1.8	.8	.9	12.5	4.7	2.5	2.6	2.3	2.6	1.1	2.5	3.0
1970	3.3	1.8	2.0	2.0	12.4	4.3	2.4	2.6	2.9	3.0	1.2	2.7	3.3
Miscellaneous													
1961	1.7	.3	1.4	1.3	9.1	1.1	1.5	1.5	1.3	2.7	3.1	1.0	2.1
1970	1.7	.3	1.5	1.2	8.0	1.2	1.6	1.5	1.3	2.9	3.1	1.0	2.1

[1] For descriptions of various land use categories, see p. 28.

RURAL LAND USES

Three of the twelve land use categories – cropland, pasture and range, and farmstead – are clearly agricultural. These uses accounted for 42 percent of the sample area in 1961, declining to 39 percent by the later period. Some agricultural land was included in other categories. Farmhouses and rural roads were included in residential and transportation, respectively. Drainage ditches and small ponds were included in miscellaneous, and the category open idle includes some land within the boundaries of operating farms. However, these acreages constitute only a small fraction of the total.

Cropland

The United States as a whole has experienced a net decline in cropland since the 1949 high of 478 million acres.[12] The net decline has resulted because additions to the cropland base through reclamation only partly offset declines occasioned by economic obsolescence. Results of this study reflect the same pattern (table 6).

Within the 53 counties, cropland declined from 32.9 to 30.4 percent of the total area. The net decline of over 500,000 acres resulted because three times more land was diverted from production than was developed as new cropland. Open idle accounted for the largest single proportion of all movements to and from cropland. While 47.5 percent of new cropland was developed from open idle land, 44.6 percent of gross cropland declines was to open idle land. The development of cropland from idle land, simultaneous with the diversion of cropland to open idle, undoubtedly reflects continuing reevaluation of land capability in light of changing technology and socioeconomic circumstances. For example, mechanization has favored development in areas where large acreages of level to gently sloping land are available. Improved fertilizer technology has enabled use of land topographically suitable but previously limited by inherent low soil fertility.

Conversions of land between pasture and cropland were balanced. A little over 100,000 acres of cropland was diverted to pasture and range while almost the same amount of pasture and rangeland was developed as cropland. On one hand, this reflects the abandonment of marginal cropland to pasture. On the other hand, it represents cropland development when dairy operations were phased out for cash crops, when wetter lands, in Florida for example, were drained, and when western rangelands were irrigated or brought into dryland farming.

After open idle, urban uses were the second largest user of gross cropland acreage diversions. Over 250,000 acres of cropland were directly converted to urban uses in the study counties between the two time periods. This equalled almost 25 percent of gross cropland losses.

Patterns of cropland change varied regionally. In all areas, except the Florida Gulf and Colorado, cropland experienced a net decline. Percentage decline over the 1961 cropland total ranged from 3.8 in the Corn Belt counties to 21.9 in the California counties and 22.6 in the Piedmont region. Range of declines in percentage of the total area in cropland was 1.8 to 4.5 percent.

Generally, in the regions in the eastern half of the country, shift to open idle land accounted for more of the overall decline in cropland than any other shift. The exception was the Piedmont, where the shift from cropland to forest was more important. The proportion of the cropland loss reverting to forest reflects both the longer interval between photograph years and the propensity within an area for spontaneous reforestation of unmanaged land. Much of the cropland decline occurred as changing technology and increased productivity in other areas resulted in the economic obsolescence of part of the cropland base.

Urban tended to be the most important subsequent use for cropland in the more western regions and the second most important subsequent use in the eastern regions. This tendency in the western regions, such as the Texas Prairie, Colorado, and California, points up the competition between cropland and urban uses for the more level terrain and in some cases for the water associated with irrigated land.

Net increase in cropland in the Florida counties resulted from conversions from open idle, pasture and range, and forest, in that order of importance. Much of the open idle land taken was grass and shrub land, with a very high water table, requiring drainage. In the Colorado counties, net increases resulted from approximately equal net conversions from open idle and pasture and range. These conversions represented some expansion of irrigated acreage and some increase in dryland wheat.

Pasture and Range

Area used for pasture and range, nonforested land showing evidence of animal use, declined from 8.1 to 7.8 percent between 1961 and 1970 (table 7).[13] The largest proportion of both gross conversions to and diversions from pasture and range involved exchanges with cropland. These conversions, occurring almost equally in both directions and contributing little to total net decline of pasture and range, possibly reflect crop rotation practices.

More pasture and rangeland was idled than was converted from open idle; open idle accounted for

[12] H. Thomas Frey, *Major Uses of Land in the United States – Summary for 1969* (U.S. Dept. Agr., Econ. Res. Serv., AER 247, 1973) p. 9.

[13] Limitations on capacity to obtain pasture and rangeland data from photo interpretation are noted in App. B.

Table 6 – Cropland changes for regional groups of the 53 study counties, 1961–1970

Item	North-east	Middle Atlantic	Piedmont	Appalachian Fringe	Florida Gulf	Jackson County, Miss.	Corn Belt	Great Lakes	South Central Prairie/ Woodland Fringe	Texas Prairie	Colorado	California	53-county total
							1,000 acres						
Cropland													
1961	657.5	354.1	310.0	487.8	153.4	13.1	1,757.8	1,129.3	518.8	989.2	615.2	183.1	7,169.5
1970	578.7	302.4	239.9	449.8	217.9	13.1	1,690.8	1,037.3	449.5	883.4	620.7	143.0	6,626.3
Net change 1961-70	–78.9	–51.7	–70.1	–38.1	+64.5	0	–67.0	–92.0	–69.3	–105.9	+5.4	–40.2	–543.2
Gross additions to cropland													
1961–1970	5.1	6.1	7.8	16.0	89.5	4.7	44.4	10.9	8.4	11.4	62.2	2.1	268.5
Converted from:[1]							*Percent*						
Pasture and range	12.3	59.4	5.3	30.5	29.1		39.6	29.7	87.4	66.5	57.8	20.8	40.1
Farmsteads				1.5	.2		1.5	4.7					.6
Open idle	75.3	40.6	54.2	62.1	50.6	52.4	48.8	51.6	10.1	31.5	41.8	79.2	47.5
Forest	12.3		37.8	5.9	14.9	47.6	9.7	12.2	2.5	2.0	.4		9.8
Urban[2]													
Water bodies more than 40 acres													
Miscellaneous			2.7		5.2		.4	1.8					2.0
							1,000 acres						
Gross declines of cropland													
1961–1970	83.9	57.8	77.9	54.1	25.0	4.7	111.4	102.9	77.7	117.3	56.7	42.2	811.7
Converted to:[1]							*Percent*						
Pasture and range	1.9	6.3	3.9	11.7	20.4		12.5	5.1	19.9	22.6	37.8	9.5	13.1
Farmsteads		.4			3.5		.2	.3		.2	.8		.3
Open idle	63.5	50.3	30.0	40.1	42.6	33.3	46.5	59.4	57.1	34.7	22.6	28.0	44.6
Forest	4.0	1.5	38.0	4.8	16.7	38.1	3.3	1.0	1.0			.9	5.9
Urban[2]	30.4	40.7	25.8	21.5	16.0	28.6	35.6	33.8	16.4	39.4	38.3	59.2	32.8
Water bodies more than 40 acres			.9	21.0			.2		5.4	2.6			2.4
Miscellaneous	.3	.7	1.3	.9	.8		1.6	.5		.5	.4	2.3	.8

[1] Percentages may not total 100.0 due to rounding.
[2] Includes residential, urban idle, transportation, recreation, and commercial-industrial-institutional uses.

Table 7 – Pasture and rangeland use changes for regional groups of the 53 study counties, 1961–1970

Item	North-east	Middle Atlantic	Piedmont	Appalachian Fringe	Florida Gulf	Jackson County, Miss.	Corn Belt	Great Lakes	South Central Prairie/ Woodland Fringe	Texas Prairie	Colorado	California	53-county total
						1,000 acres							
Pasture and range													
1961	27.3	36.8	7.0	60.6	124.3	1.1	119.0	41.8	412.1	459.7	294.4	187.3	1,771.5
1970	23.9	32.5	6.6	55.1	108.3	–	99.8	34.8	387.0	466.5	308.1	185.2	1,707.9
Net change 1961–1970	–3.4	–4.3	–.4	–5.5	–16.0	–1.1	–19.2	–7.0	–25.1	+6.8	+13.7	–2.1	–63.6
Gross additions to pasture and range													
1961–1970	2.0	3.9	3.2	7.8	29.0	–	18.1	6.9	19.5	29.6	65.5	5.3	191.0
							Percent						
Converted from:[1]													
Cropland	79.3	95.2	93.6	80.7	17.6		76.7	76.4	79.4	89.6	32.7	75.6	55.7
Farmsteads	9.8	4.8											.1
Open idle	10.8			10.3	59.7		21.8	17.8	1.1	5.4	66.2	16.2	36.5
Forest			6.4	9.1	20.4		1.4	5.8	19.5	5.0	1.1	8.1	7.3
Urban[2]													
Water bodies more than 40 acres					2.4								.4
Miscellaneous													
						1,000 acres							
Gross declines of pasture and range													
1961–1970	5.4	8.2	3.6	13.3	45.1	1.1	37.3	13.9	44.6	22.8	51.8	7.4	254.6
							Percent						
Converted to:[1]													
Cropland	11.6	44.5	11.6	36.6	57.8		47.0	23.2	16.5	33.3	69.4	5.8	42.3
Farmsteads													
Open idle	55.3	44.3	17.6	45.2	16.4		44.8	64.1	63.0	27.6	27.4	59.7	39.0
Forest	11.1	5.2	70.8	12.5	11.5	100.0	7.0	1.6	8.2				7.1
Urban[2]	17.9	3.4		5.7	14.2		1.3	11.0	9.0	35.9	2.7	34.4	10.4
Water bodies more than 40 acres									2.9	.8			.6
Miscellaneous	4.1	2.6							.4	2.4	.5		.6

[1] Percentages may not total 100.0 due to rounding.
[2] Includes residential, urban idle, transportation, recreation, and commercial-industrial-institutional uses.

almost 50 percent of the net decline in grazed land. Conversions to urban uses accounted for a little over 40 percent of the net decrease.

Only two regions, the Texas Prairie and Colorado, did not experience a net decline in pasture and rangeland. These two regions were also the regions with the largest proportions of pasture and range. The major source of additional grazed land varied for each area and seem to imply that different processes were active. In Colorado, open idle land was the main source of new pasture and range, while cropland was the major destination of diversions from rangeland. This suggests a pattern of escalating intensity of land use. The Florida region evidenced the same pattern of increasing intensity, even though it experienced a net decline in total pasture and rangeland. Conversely, in the Texas Prairie, cropland was the primary source of pasture and rangeland increase, representing a decrease in intensity of use. The pattern of decreasing intensity of rural land uses is typical of all regions except Florida and Colorado.

Farmsteads

Farmsteads accounted for less than 1 percent of the area in the study counties and represent a relatively static land use (table 8). Reflecting the overall trend in agricultural land, the area in farmsteads declined between the two sampled times. However, the decline was proportionally less than that of cropland. This probably reflects the increased importance of machinery in agricultural production, or in areas where urbanization has occurred, the conversion of structures to nonagricultural uses, or the abandonment of remnants uneconomic to convert or remove.

Open idle land

Open idle land, unforested land showing no evidence of other use, for all 53 counties declined from 9.5 to 9.0 percent of study area (table 9). This decline is largely due to net decreases in two areas, the Florida and Colorado counties. These areas also exhibited patterns of open idle land use changes different from those of the other regions. For this reason, these two areas are not considered in the overall grouping of counties and are discussed separately.

When the Florida and Colorado regions are not included, the remaining areas showed a 5-percent increase of open idle over the 1961 total. The overall flows in the nine regions were from agricultural land to open idle land and from open idle land to urban uses. Six times more land was diverted from agricultural uses to open idle than was developed from open idle for cropland and pasture. The open idle-urban flow was virtually unidirectional, with a net flow of 193,500 acres to urban uses. These flows would have resulted in a net increase of open idle land in these regions of 225,200 acres. This increase in open idle was partially offset by another important pattern of movement, open idle to forest land. Twice as much land went to forest from open idle than to open idle from forest. While this net conversion of open idle to forest may have resulted in more intensive use of some of the land for recreation or forestry, it probably reflected simply a change in cover, not intensification of use.

These patterns were substantially the same for each of these nine areas. The magnitude of flows varied somewhat depending on the original land use bases of the regions. For instance, in three areas – Middle Atlantic, Piedmont, and Appalachian Fringe – idle land decreased. While the basic flows in the land use transition matrix were the same as those for the nine-region total, in these areas, where spontaneous reforestation is rapid, net increases in open idle land were offset by conversions of open idle to forest.

The pattern of open idle land dynamics differed in Florida and Colorado. In Florida, level, wet, idle lands are being drained for cropland. Irrigated and dryland farming techniques have extended the areas productively used for crops and grazing in the Colorado counties. In both these regions, the decreases in open idle land have been augmented by conversion of open idle land to urban uses. Open idle land was further reduced in Florida because of spontaneous reforestation.

Forest land

Forest land declined slightly from 30.5 to 30.1 percent of the sample area. The dynamics of forest land change were relatively uncomplicated (table 10). Shifts involving cropland, pasture and range, and open idle resulted in net increases to forest. Cropland reverting to forest was almost twice as much as that developed from forest. Forest reclaimed 30 percent more pasture and range than was developed from forest, whereas 2.4 times more open idle land grew up to forest than was cleared from forest. These increases, however, were offset by the net losses of forest to urban, farmstead, water bodies, and miscellaneous uses. Conversion of forested land to urban uses was the most important source of decline, accounting for 62.7 percent of all losses of forest land.

Regionally, the overall pattern of woodland losses to urban, water, and miscellaneous uses was replicated within each of the eleven groups. There was more regional variation in dynamics of interchange of forest with cropland, pasture and range, and open idle. In the most forested regions, the Piedmont, California, Northeast, Middle Atlantic, and Appalachian Fringe, a pattern of net increases of forest was maintained by conversions from open idle, cropland, and pasture and range in order of importance. But in the least forested areas, for example the Texas Prairie and Colorado, forest showed a net loss to *all* other land uses.

Table 8 – Changes in land use for farmsteads for regional groups of the 53 study counties, 1961–1970

Item	North-east	Middle Atlantic	Piedmont	Appalachian Fringe	Florida Gulf	Jackson County, Miss.	Corn Belt	Great Lakes	South Central Prairie/ Woodland Fringe	Texas Prairie	Colorado	California	53-county total
							1,000 acres						
Farmsteads													
1961	14.0	13.0	7.1	16.6	3.6	–	49.9	34.9	15.5	26.2	7.9	4.0	192.7
1970	13.2	12.5	7.3	16.4	6.3	–	49.7	34.5	15.3	24.7	7.6	3.6	191.1
Net change 1961–1970	–.8	–.5	+.2	–.2	+2.7	–	–.2	–.4	–.2	–1.5	–.3	–.4	–1.6
Gross additions to farmsteads 1961–1970	–	.2	.2	–	3.1	–	.9	.3	.2	.2	.7	–	5.9
							Percent						
Converted from:[1]													
Cropland		100.0			28.3		29.8	100.0	100.0	100.0	66.9		40.4
Pasture and range													
Open idle					41.4		23.8				33.1		32.8
Forest			100.0		30.3		46.4						26.8
Urban[2]													
Water bodies more than 40 acres													
Miscellaneous													
							1,000 acres						
Gross declines of farmsteads 1961–1970	.8	.7	–	.2	.4	–	1.1	.7	.4	1.7	1.0	.4	7.5
							Percent						
Converted to:[1]													
Cropland				100.0	42.3		60.1	74.4					20.9
Pasture and range	24.0												2.6
Open idle	24.8				57.7		19.7		100.0	53.9	24.8	100.0	32.1
Forest											24.8		3.1
Urban[2]	51.2	100.0					20.2	25.6		46.2	75.3		41.1
Water bodies more than 40 acres													
Miscellaneous													

[1] Percentages may not total 100.0 due to rounding.
[2] Includes residential, urban idle, transportation, recreation, and commercial-industrial-institutional uses.

Table 9 – Changes in open idle land for regional groups of the 53 study counties, 1961–1970

Item	North-east	Middle Atlantic	Piedmont	Appalachian Fringe	Florida Gulf	Jackson County, Miss.	Corn Belt	Great Lakes	South Central Prairie/ Woodland Fringe	Texas Prairie	Colorado	California	53-county total
						1,000 acres							
Open idle land													
1961	217.2	83.9	126.9	91.0	440.7	71.7	247.4	173.4	173.5	147.6	245.2	42.2	2,060.8
1970	238.6	82.5	91.0	80.7	320.6	65.7	248.5	225.2	202.2	162.5	192.1	47.0	1,956.7
Net change 1961–1970	+21.4	–1.4	–35.9	–10.3	–120.1	–6.0	–1.1	+51.8	+28.7	+14.9	–53.1	+4.8	–104.1
Gross additions to open idle 1961–1970	64.5	36.7	44.6	30.5	43.4	9.3	79.4	76.1	79.4	54.4	32.3	17.1	567.6
							Percent						
Converted from:[1]													
Cropland	82.6	79.1	52.5	71.0	24.6	16.7	65.3	80.3	55.9	74.8	39.7	69.3	63.8
Pasture and range	4.6	10.0	1.4	19.7	17.0		21.1	11.7	35.4	11.6	44.0	25.9	17.5
Farmsteads	.3				.5		.3		.5	1.7		2.3	.4
Forest	11.8	10.4	43.9	7.8	23.7	61.9	9.5	5.0	7.4	10.8	2.9	1.3	13.0
Urban[2]	.3	.6	1.7	1.5			.6	3.0		1.0	13.3		1.6
Water bodies more than 40 acres					4.7	21.4	2.5		.8			1.1	1.2
Miscellaneous	.3		.5		29.5		.7						2.4
							1,000 acres						
Gross declines of open idle 1961–1970	43.1	38.1	80.4	40.8	163.5	15.3	78.3	24.3	50.6	39.5	85.4	12.3	671.7
							Percent						
Converted to:[1]													
Cropland	8.9	6.5	5.3	24.3	27.7	15.9	27.7	23.1	1.7	9.1	30.4	13.4	19.0
Pasture and range	.5	.5		2.0	10.6		5.1	5.1	.4	4.0	50.8	7.0	10.4
Farmsteads					.8		.3		.4		.3		.3
Forest	34.0	40.6	44.2	32.5	33.6	60.9	24.1	25.1	8.7			20.8	26.1
Urban[2]	54.0	51.1	30.4	39.4	23.9	21.7	38.5	46.6	69.7	72.0	17.2	55.6	37.4
Water bodies more than 40 acres	1.0	.6	19.5	1.7			1.1		17.9	11.1	1.1		4.8
Miscellaneous	1.5	.7	.7		3.4	1.4	3.3		1.2	3.7	.3	3.2	1.9

[1] Percentages may not total 100.0 due to rounding.
[2] Includes residential, urban idle, transportation, recreation, and commercial-industrial-institutional uses.

Table 10 – Changes in forest land for regional groups of the 53 study counties, 1961–1970

Item	North east	Middle Atlantic	Piedmont	Appalachian Fringe	Florida Gulf	Jackson County, Miss.	Corn Belt	Great Lakes	South Central Prairie/ Woodland Fringe	Texas Prairie	Colorado	California	53-county total
							1,000 acres						
Forest land													
1961	1,327.6	546.5	994.4	450.3	408.5	352.5	797.7	377.9	614.5	197.3	9.3	575.5	6,652.0
1970	1,288.2	543.3	974.1	457.4	432.9	347.4	799.6	371.2	578.8	177.4	7.6	574.2	6,552.0
Net change 1961–1970	−39.4	−3.2	−20.3	+7.1	+24.4	−5.1	+1.9	−6.7	−35.7	−19.9	−1.7	−1.3	−100.0
Gross additions to forest land 1961–1970	18.6	16.8	67.7	17.5	65.4	12.2	25.8	7.3	8.9	–	.2	3.0	243.4
							Percent						
Converted from:[1]													
Cropland	18.0	5.2	43.7	14.8	6.4	14.5	14.2	13.4	9.0			13.2	19.8
Pasture and range	3.2	2.5	3.7	9.5	8.0	9.1	10.1	3.1	41.2				7.4
Farmsteads											100.0		.1
Open idle	78.8	92.3	52.5	75.7	84.1	76.4	73.2	83.5	49.8			86.7	72.0
Urban[2]							.8						.1
Water bodies more than 40 acres							1.7						.2
Miscellaneous					1.6								.4
							1,000 acres						
Gross declines of forest land 1961–1970	58.0	20.0	88.0	10.4	41.0	17.3	23.9	14.0	44.6	19.9	1.9	4.3	343.4
							Percent						
Converted to:[1]													
Cropland	1.1		3.4	9.1	32.4	12.8	18.1	9.4	.5	1.2	12.6		7.7
Pasture and range			.2	6.8	14.4		1.1	2.9	8.6	7.4	37.5	10.1	4.1
Farmsteads			.2		2.2		1.8						.5
Open idle	13.1	19.1	22.2	22.8	25.0	33.3	31.8	27.3	13.2	29.4	49.9	5.0	21.5
Urban[2]	85.7	79.8	68.1	52.2	25.3	52.7	42.1	58.8	77.8	53.7		29.3	62.7
Water bodies more than 40 acres			4.3	6.8			2.7			7.3		50.5	2.6
Miscellaneous		1.1	1.6	2.3	.5	1.3	2.5	1.6		1.0		5.0	1.0

[1] Percentages may not total 100.0 due to rounding.
[2] Includes residential, urban idle, transportation, recreation, and commercial-industrial-institutional uses.

URBAN LAND USES

Five of the designated land use categories – residential, urban idle, transportation, recreation, and commercial-industrial-institutional – were grouped to summarize urban uses. Urban land use accounted for 16.4 percent of the study area in 1970, up from 12.9 percent in the earlier sample. As expected, the dynamics of conversion to urban use are overwhelmingly unidirectional (table 11). While over three quarters of a million acres were converted to urban use from nonurban uses, less than .4 percent of 1961 urban land was diverted to nonurban uses. In addition, about 1 percent of the 1961 urban land experienced intraurban change between 1961 and 1970.

Of the approximately 10,000 acres diverted to nonurban uses, 93 percent was to open idle. Of these 9,300 acres reverting to open idle, 87 percent was from commercial-industrial-institutional use. Half of this change was due to removal of installations in the Rocky Mountain Arsenal in Adams County, Colo.

Agricultural land accounted for the largest proportion of land converted to urban use between the two time periods. Cropland, which provided 35 percent, was the largest single source of land for urban development. Proportionally, its contribution to urban development was only slightly larger than its total proportion of the study area during the earlier period. The amount of development on cropland might have been expected to be higher as cropland has characteristics such as moderate slope, good drainage, and very little waste area, which make it especially amenable to urban development. Pasture and range accounted for 3.5 percent, which is less than half its proportional share of the land in the study area. Pastureland probably has higher developmental costs because of greater slope and more wasteland than cropland. Also, the extensive rangelands in Florida and the Western States tend to be more distant from built-up areas.

The second most important source of land for urban development was open idle land, accounting for 33 percent of new conversions. This was about 3.5 times greater than might have been anticipated proportional to the amount of idle land in the study area. Some of this land was undoubtedly idle in direct anticipation of or in preparation for urban development.

The 28-percent of urban development which took place on forest land was proportionally slightly less than forest's percentage of the study area. The percentage was perhaps more than might be expected as developmental costs are higher on forested land. However, counter to this handicap would be the amenity value trees add in urban areas. Underestimation of forest land converted to urban uses may also have occurred as facilities beneath tree cover, such as buildings or picnic tables, may not have been visible on the photos. Together, agricultural, open idle, and forest land accounted for 99 percent of the development of new urban land between the two time periods.

Regionally, the percentage of urban development at the expense of different categories of nonurban land varied greatly. The proportion of urban development on cropland varied from 6 to 70 percent. New urban uses developed on open idle land varied from 19 to 61 percent. For forest, the proportion ranged from 4 to 57 percent. The percentage of urban development on pasture and rangeland was substantially less variable.

Generally, the proportion of new urban development on different nonurban land types appeared to show some positive relation to the proportion of the land types in each area. Thus, where rapid population growth occurred, causing increased urban land use needs, the development expanded onto whatever land was proximate, barring any unusual difficulties or excessive costs.

The California counties might seem to be an exception to this generalization, for in 1961, only 16.3 percent of the area was in cropland, yet 70 percent of the 1961-70 urban development occurred on cropland. In 1961, a little over 50 percent of the area was in forest, yet only 3.5 percent of new urban development was on forest land. However, in this area, much of the wooded land is steeply sloped, sometimes with soil slippage problems, requiring high costs for urban development. In this region, climatically suited to a variety of high value specialty crops, competition is fierce between agricultural and urban uses for the more gently sloped land. Where population pressure is great, the high-value-per-acre urban uses can outbid agricultural uses.[14]

Components of Urban Land Use

The proportion of development of individual urban uses from nonurban lands was quite similar to the proportions for all urban uses considered together (table 12). Variations which occurred can be readily rationalized. Residential development on forest land occurred at a higher rate than did overall urban development or any other specific urban use, reflecting the amenity value of forested areas and the greater locational flexibility of this urban use.

Proportionally, transportation's taking of forest was very close to the percent of forest land in the sample area, whereas the percentage of development from open idle land was the lowest of any urban use. Transporta-

[14] This pattern of urban development is responsible for the continuing concern about urbanization of California cropland as evidenced in the following: Griffin and Chatham, "Urban Impact on Agriculture in Santa Clara County, California;" Curtis C. Harris, Jr. and David J. Allee, *Urbanization and Its Effects on Agriculture in Sacramento County, California.* Vol. 1. *Urban Growth and Agricultural Land Use;* and C. Richard Shumway, and others, *Regional Resource Use for Agricultural Production in California, 1961-65 and 1980* (Giannini Found. Mon. 25, 1970).

Table 11 – Changes in urban land for regional groups of the 53 study counties, 1961–1970[1]

Item	North east	Middle Atlantic	Piedmont	Appalachian Fringe	Florida Gulf	Jackson County, Miss.	Corn Belt	Great Lakes	South Central Prairie/ Woodland Fringe	Texas Prairie	Colorado	California	53-county total
							1,000 acres						
Urban land													
1961	450.5	195.8	234.8	152.0	72.4	20.4	525.2	228.1	345.7	406.7	80.3	90.2	2,802.1
1970	550.2	255.6	338.9	185.8	136.4	34.2	605.3	281.9	432.5	500.2	115.0	125.9	3,561.8
Net change 1961–1970	+99.7	+59.8	+104.1	+33.8	+64.0	+13.8	+80.1	+53.8	+86.8	+93.5	+34.7	+35.7	+759.7
Gross additions to urban land 1961–1970	99.9	60.0	104.9	34.2	64.0	13.8	80.8	56.1	86.8	94.6	39.0	35.7	769.7
							Percent						
Converted from:[2]													
Cropland	25.5	39.3	19.2	34.1	6.2	9.7	49.2	62.0	14.8	48.8	55.8	70.1	34.6
Pasture and range	1.0	.5		2.2	10.0		.6	2.7	4.6	8.7	3.6	7.2	3.5
Farmsteads	.4	1.2					.3	.3		.9	1.8		.4
Open idle	23.3	32.4	23.3	47.1	61.1	24.2	37.3	20.2	40.7	30.1	37.5	19.2	32.8
Forest	49.8	26.6	57.2	15.9	16.2	66.1	12.4	14.8	39.9	11.3		3.5	28.0
Water bodies more than 40 acres					1.1		.3						.1
Miscellaneous			.3	.7	5.4					.2	1.2		.6
							1,000 acres						
Gross declines of urban land 1961–1970	.2	.2	.8	.5	–	–	.7	2.3	–	1.1	4.1	–	10.0
							Percent						
Converted to:[2]													
Cropland													
Pasture and range													
Farmsteads													
Open idle	100.0	100.0	100.0	100.0			68.0	100.0		25.0	100.0		92.7
Forest							32.0						2.1
Water bodies more than 40 acres										50.0			3.5
Miscellaneous										25.0			1.7

[1] Includes residential, urban idle, transportation, recreational, and commercial-industrial-institutional use.
[2] Percentages may not total 100.0 due to rounding.

Table 12 – Proportion of new urban land uses developed from nonurban land, 53 study counties, 1961–1970

Urban uses	Nonurban uses						
	Cropland	Pasture and range	Farmsteads	Open idle	Forest	Water bodies over 40 acres	Miscellaneous
	Percent						
All urban land	34.6	3.5	.4	32.8	28.0	.1	.6
Residential	32.6	2.5	.2	33.0	31.1	.2	.5
Urban idle	40.9	–	–	32.8	26.3	–	–
Transportation	40.9	6.3	.5	20.5	30.0	–	1.8
Recreation	41.3	9.5	–	30.9	16.9	.7	.7
Commercial-industrial-institutional	34.7	3.1	1.1	41.0	20.1	–	.1

tion also had the highest percentage of development on miscellaneous land. This pattern of conversion to transport use is because transportation involves not only local movement, but also through travel over terrain unsuitable for other intensive development.

A comparatively low percentage of recreational development was on forest land. This reinforces an earlier point that airphoto interpretation's reliance on cover to indicate use results in some distortions and inaccuracies. The more easily identifiable recreation uses – amusement parks, playing fields, and golf courses – are likely to be developed on more level open land (cropland, for instance). However, picnic areas and riding and hiking trails may be masked by tree cover. Whereas none of the commercial-industrial-institutional development occurred at water's expense, water edges were modified by some residential and recreational development, reflecting the amenity value of water frontage.

Intraurban Land Transfers

The incidence of intraurban land use change was low and the individual figures have little statistical validity. However, they suggest a pattern of succession of escalating intensity of use (table 13). This succession results when changing circumstances enable a higher return if the land use is altered.[15] The costs of supersession, writing off of investments in improvements already located on a site, are borne at the promise of higher returns. Thus, no land reverted from any urban use to urban idle, as defined in our study. (If an urban structure were no longer actively employed, this would not be easily interpretable from aerial photography.) No commercial-industrial-institutional land, the most intensive urban use, was converted to other urban uses. Conversions of residential land were only to transportation and commercial-industrial-institutional.

[15] Raleigh Barlowe, *Land Resource Economics*, p. 187.

Table 13 – Intraurban land use transfers, 53 study counties, 1961–1970

1961 urban uses	1970 urban uses					
	Residential	Urban idle	Transportation	Recreation	Commercial-industrial-institutional	1961 totals
	1,000 acres					
Residential	–	–	2.1	–	1.6	3.7
Urban idle	17.0	–	1.9	1.0	11.6	31.5
Transportation	–	–	–	1.1	–	1.1
Recreation	.2	–	.3	–	.2	.8
Commercial-industrial-institutional	–	–	–	–	–	–
1970 totals	17.2	–	4.4	2.1	13.4	37.1

The only possible exception to the pattern of increasing intensity of urban land uses was shift of some transportation areas to recreation. These accounted for less than 3 percent of the intraurban land conversions.

OTHER LAND USES

Water

Area in water bodies over 40 acres increased from 3.0 to 3.3 percent of the study area. Seven times more land was converted to water area than was converted from water area to other uses (table 14). Ninety percent of the gross increase occurred in four regions – the

Table 14 – Changes in water bodies over 40 acres for regional groups of the 53 study counties, 1961–1970

Item	North-east	Middle Atlantic	Piedmont	Appalachian Fringe	Florida Gulf	Jackson County, Miss.	Corn Belt	Great Lakes	South Central Prairie/ Woodland Fringe	Texas Prairie	Colorado	California	53-county total
						1,000 acres							
Water bodies over 40 acres													
1961	93.6	22.4	13.6	11.0	192.2	22.9	90.6	54.5	49.1	60.9	15.0	27.9	653.6
1970	94.0	22.6	33.7	25.7	189.5	20.9	89.6	54.5	63.4	70.5	15.9	30.2	710.7
Net change 1961–1970	+.4	+.2	+20.1	+14.7	−2.7	−2.0	−1.0	–	+14.3	+9.6	+.9	+2.3	+57.1
Gross additions to water bodies over 40 acres													
1961–1970	.4	.2	20.1	14.7	–	–	1.7	–	15.0	9.6	.9	2.5	65.3
							Percent						
Converted from:[1]													
Cropland			3.4	77.4			12.5		28.1	31.6			29.9
Pasture and range									8.5	2.0			2.2
Farmsteads													
Open idle	100.0	100.0	77.8	4.8			49.9		60.5	45.8	100.0		49.5
Forest			18.8	4.8			37.6			15.2		84.6	13.4
Urban[2]										3.6			.5
Miscellaneous				13.0					2.8	1.8		15.4	4.4
						1,000 acres							
Gross declines of water bodies over 40 acres													
1961–1970	–	–	–	–	2.7	2.0	2.7	–	.7	–	–	.2	8.2
							Percent						
Converted to:[1]													
Cropland													
Pasture and range													
Open idle													
Forest					74.4	100.0	74.4		100.0			100.0	83.2
Urban[2]							16.3						5.3
Miscellaneous					25.6		9.3						11.5

[1] Percentages may not total to 100.0 due to rounding.
[2] Includes residential, urban idle, transportation, recreation, and commercial-industrial-institutional uses.

Piedmont, Appalachian Fringe, South Central Prairie/ Woodland Fringe, and Texas Prairie.

Open idle land accounted for about half of the land developed for new water areas and was the most important source for increase in three of these four regions. The second most important source of land for water development was cropland which accounted for almost 30 percent of gross increase. Over 75 percent of gross conversions to water in the Appalachian Fringe was from cropland. The propensity for development of water bodies from cropland and open idle probably reflects inundation of valleys and bottom lands behind dams.

Miscellaneous

Miscellaneous uses, accounting for about 2 percent of the total study area, showed only a slight net decrease between sampled periods. Gross additions were evenly spread throughout the regions and mainly reflected development of ponds and water management ditches on open idle land and cropland (table 15). Patterns of gross declines were more variable. Eighty percent of the gross decreases occurred in the Florida counties and mainly involved development of the wetlands. Most of these converted wetlands were not immediately developed beyond drainage, as 57 percent of all losses from miscellaneous category in the Florida counties was to open idle. A substantial portion though – 21 percent – was used for cropland and 14 percent was developed for urban uses. If the Florida counties are not considered, all miscellaneous would have increased to 2.2 percent of the total area. When the Florida counties were excluded from total figures, 50 percent of the diversion of miscellaneous land was to water bodies over 40 acres.

PER CAPITA LAND USE CHANGES

Land use coefficients, ratios of land use to population, can be used to describe land use patterns. Procedures for deriving coefficients do not vary significantly in general formulation but do differ in definition of the land use and population variables. For this study, the urban land use coefficient *(U)* was calculated:

$$U = \frac{\frac{A_2 - A_1}{T_2 - T_1}}{\frac{P_2 - P_1}{T_2 - T_1}}$$

where: A_2 was the urban land in a county in the second time period;

A_1 was the urban land in a country in the first time period;

T_2 was the year of the later photography;

T_1 was the year of the earlier photography;

P_2 was the population of a county during the second year of photography; and

P_1 was the population of a county during the first year of photography.

To calculate multi-county coefficients, the average yearly changes were combined.

The residential land use coefficents *(R)* were calculated:

$$R = \frac{\frac{H_2 - H_1}{T_2 - T_1}}{\frac{P_2 - P_1}{T_2 - T_1}}$$

where: H_2 was the acreage in residential use in T_2;

H_1 was the acreage in residential use in T_1; and the other variables were the same as in the previous equation.

The inverse of these coefficients, expressing the average density of new urban or residential development, may also be used to describe the land-to-population relationship.

Had the time intervals been the same for all counties, coefficients of losses of particular uses to urban land could be simply calculated by multiplying the urban land use coefficients by the percentage of each non-urban use contributed. Since this was not the case, to obtain more precise coefficients, it was necessary to derive them in the same manner as the urban land coefficients. Thus the loss of cropland to urban use per population increase (cropland urbanized coefficient, *C*) was calculated:

$$C = \frac{\frac{c}{T_2 - T_1}}{\frac{P_2 - P_1}{T_2 - T_1}}$$

where: c was the number of acres converted from cropland to urban use between times T_1 and T_2, and the other variables were the same as those in the previous equations.

Table 15 – Changes in land in miscellaneous uses for regional groups of the 53 study counties, 1961–1970

Item	North-east	Middle Atlantic	Piedmont	Appalachian Fringe	Florida Gulf	Jackson County, Miss.	Corn Belt	Great Lakes	South Central Prairie/ Woodland Fringe	Texas Prairie	Colorado	California	53-county total
							1,000 acres						
Miscellaneous land													
1961	47.5	3.2	23.4	16.3	139.0	5.3	53.4	29.8	28.7	64.5	40.7	10.6	462.3
1970	48.4	4.3	25.6	14.8	122.4	5.8	57.6	30.3	29.0	67.1	40.9	11.8	458.0
Net change 1961–1970	+.9	+1.1	+2.2	−1.5	−16.6	+.5	+4.2	+.5	+.3	+2.6	+.2	+1.2	−4.3
Gross additions to miscellaneous 1961–1970	1.1	1.1	2.9	.7	6.0	.4	4.9	.7	.8	2.9	.7	1.6	24.0
							Percent						
Converted from:[1]													
Cropland	21.2	37.4	35.4	66.7	3.5		35.2	69.3	25.0	19.5	33.3	61.7	26.8
Pasture and range	19.9	18.3							75.0	18.6	33.3		5.9
Farmsteads													
Open idle	58.9	25.3	17.8		92.9	50.0	52.5			49.5	33.3	24.7	52.1
Forest		19.0	46.8	33.3	3.6	50.0	12.3	30.8		6.5		13.6	14.6
Urban[2]										5.9			.7
Water bodies more than 40 acres													
							1,000 acres						
Gross declines of miscellaneous 1961–1970	.2		.7	2.2	22.6		.8	.2	.4	.4	.5	.4	28.4
							Percent						
Converted to:[1]													
Cropland			28.5		20.6		23.9	100.0					18.4
Pasture and range					3.1								2.5
Farmsteads													
Open idle	100.0		28.5		56.6		76.1						48.8
Forest					4.6								3.7
Urban[2]			42.9	11.0	14.1					52.3	100.0		16.3
Water bodies more than 40 acres				89.0	1.0				100.0	47.7		100.0	10.2

[1] Percentages may not total to 100.0 due to rounding.
[2] Includes residential, urban idle, transportation, recreation, and commercial-industrial-institutional uses.

Densities of urban and residential land use were also derived for each time period by dividing the estimated population for each year of photography by the amount of urban and residential land derived from the photo interpretation.

Urban and Residential Coefficients

If efficiency is defined as minimization of land consumed per person for urban and residential uses, then use of land for these purposes became more efficient during the study interval (tables 16 and 17). The urban land use coefficient *(U)* for the 53 combined counties was .173 acres per person. New urban development occurred at a density of 5.8 persons per acre, which raised the urban land use density from 4.3 persons per acre for the earlier period to 4.5 persons per acre during the later period. The residential land use coefficient was 9.4 persons per acre, increasing the residential density between the two times from 8.3 to 8.5 persons per acre.

Regionally, the density of urban and residential land use patterns varied considerably. There was some evidence to suggest a regionally identifiable tendency for new urban development to use land more efficiently in areas where cropland was a relatively more important source of land for new urban development. Simple regression of regional values of density of new urban development (y) to regional percents of new urban development occurring on cropland (x) yielded an r of .57. Two regions – the Great Lakes and South Central Prairie/Woodland Fringe – were exceptions to this generalization, and their omission from correlation raises r to .73. Areas with the highest density of new urban development were California, the Middle Atlantic, and Corn Belt, in that order. Such compactness of urban development was especially advantageous in the California counties where 70 percent of new urban land was developed from cropland, much of which is prized for its special agricultural attributes. Conversely, in the Florida Gulf region where the land use coefficient was .481 and urban density was the lowest for all regions, only 6 percent of new urban development occurred on cropland.

There were regional similarities between the residential land use coefficients and the overall land use coefficients, as residential use constituted the largest proportion of urban use. Higher densities of new residential development also occurred in areas where relatively larger proportions of new urban development were on cropland. The California, Great Lakes, and Corn

Table 16 – Urban land use coefficients and population densities of urban land by regions for the 53 study counties

Region	Urban land use coef. *(U)*	Density of new urban development $(\frac{1}{U})$	Average population density of urban land	
			Earlier period	Later period
	Acres per person	*Persons per acre*	*Persons per acre*	
Northeast	.181	5.5	3.9	4.2
Middle Atlantic	.137	7.3	5.5	6.0
Piedmont	.216	4.6	4.1	4.3
Appalachian Fringe	.275	3.6	2.8	3.0
Florida Gulf	.481	2.1	2.1	2.1
(Jackson Co., Miss.)	(.370)	(2.7)	(2.5)	(2.6)
Corn Belt	.142	7.0	4.1	4.5
Great Lakes	.173	5.8	5.0	5.2
South Central Prairie/Woodland Fringe	.146	6.8	4.9	5.3
Texas Prairie	.202	5.0	4.4	4.5
Colorado	.234	4.3	2.3	2.9
California	.097	10.3	5.8	7.1
53-county total	.173	5.8	4.3	4.5

Table 17 – Residential land use coefficients and population densities of residential land by region for the 53 study counties

Region	Residential land use coef. *(R)*	Density of new residential development $(\frac{1}{R})$	Average population density of residential land	
			Earlier period	Later period
	Acres per person	*Persons per acre*	*Persons per acre*	
Northeast	.109	9.2	6.6	7.3
Middle Atlantic	.095	10.5	9.9	10.1
Piedmont	.141	7.1	9.3	8.5
Appalachian Fringe	.154	6.5	5.6	5.7
Florida Gulf	.341	2.9	4.7	3.7
(Jackson Co., Miss.)	(.239)	(4.2)	(4.5)	(4.4)
Corn Belt	.092	10.9	8.1	8.5
Great Lakes	.075	13.3	11.3	11.8
South Central Prairie/Woodland Fringe	.117	8.5	8.8	8.8
Texas Prairie	.092	10.9	8.1	8.5
Colorado	.131	7.6	10.2	8.7
California	.057	17.5	10.6	12.7
53-county total	.106	9.4	8.3	8.5

Belt regions exemplified this tendency. Regression comparison of regional density of new residential development (y) to percent of new residential development that occurred on cropland (x) yielded an r value of .78. Thus, residential development exhibited an even stronger association between density of new development and the proportion of that development occurring on cropland. Cropland has less waste – unusable or very expensive to develop areas – than does other rural land. Thus, on cropland, a developer may build more units per acre at a lower cost per unit.

In no region was there a trend toward decreasing intensity of total urban use. However, four regions – Piedmont, Florida Gulf, South Central Prairie/Woodland Fringe, and Colorado – experienced new residential development at lower densities than the existing residential development. The low residential density figures in the Florida area resulted not only from large size lots, but also from numerous vacant lots, which have been platted and for which roads and other infrastructure, but not houses, have been built.

Density of development of past and new urban and residential land was calculated for groupings of the study counties by degree of integration within SMSA's. Variation of coefficients for the various urban orientation groupings of the counties is minimal (table 18). The first group, which contained six non-SMSA counties, did exhibit a pattern of continued lower density of urban development than did the other groups. However, the other five groupings showed relatively little differentiation. This was especially true of the three groups with SMSA counties containing at least some urbanized area. The ranges in coefficient values of regional groups as compared to the urban groups results partly from the numerical variation of group sizes. It also reflects the importance of regional variations in land use patterns when counties studied have some common characteristics.

Coefficients derived in this study were compared to those resulting from other research. Results are presented below. It must be remembered that definitions of variables and methods of data collection differed among studies. From aerial photographic research of land urbanized between 1950 and 1960 in 96 counties scattered throughout the Northeastern United States, an urban land use coefficient of .22 acres per person was derived.[16] This compares favorably with the U values for the Northeast and Middle Atlantic regions – .18 and .14 respectively – as it was demonstrated that more recent urban development has occurred at higher densities (table 16). A study of land use change in New York State in the 1950's and 1960's resulted in a calculation of .1935 acres per person coefficient for per capita population increase outside cities and village boundaries.[17]

An airphoto study of land use changes from 1950 to 1960 in 48 counties in eight far Western States concluded that land was urbanized at the rate of .071 acres per capita increase in population.[18] While this compares well with this study's value of .097 acres per capita increase in the California counties, it is much lower than the observed rate of conversion in the Colorado counties. A more recent study of land use change in Colorado included county data for Weld County, which is similar in situation to the two Colorado counties in this study, Adams and Arapahoe. In Weld County, .44 acres were urbanized per capita increase from 1950 to 1960 and .10 acres from 1960 to 1970 for an overall value of .17 for the 20-year period.[19] This compares more favorably with the U value of .234 derived in this study's Colorado counties, which applied to changes from approximately 1957 to 1969.

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[16] Henry W. Dill, Jr. and Robert C. Otte, *Urbanization of Land in the Northeastern United States* (U.S. Dept. Agr., Econ. Res. Serv., ERS-485, Washington, D.C., 1971) p. 7.

[17] Allee and others, *Toward the Year 1985,* p. 20.

[18] Henry W. Dill, Jr. and Robert C. Otte, *Urbanization of Land in the Western States* (U.S. Dept. Agr., Econ. Res. Serv., ERS-428, Washington, D.C., 1970) p. 7.

[19] Raymond L. Anderson, *Rate of Urbanization of Rural Lands in the Northern Colorado Front Range Area of Boulder, Weld and Larimer Counties, Colorado* (Colorado State Univ., Ext. Serv., 1974) p. 10.

Table 18 – Population densities of new urban and residential development (1961–1970) and density of urban and residential development for the earlier period (1961) by urban orientation groupings of the 53 study counties

Area	Density new urban development ($\frac{1}{U}$)	Average density urban development, earlier sample	Density new residential development ($\frac{1}{R}$)	Average density urban development, earlier sample
	Persons per acre			
Non-SMSA counties	2.4	2.4	4.4	5.3
Urbanized non-SMSA county	5.8	4.6	6.6	8.0
SMSA counties containing:				
No urbanized areas	2.8	3.2	4.2	7.9
Urbanized areas	6.2	4.3	11.1	8.4
Part SMSA central city	6.9	4.6	9.9	8.4
Entire SMSA central city	6.1	4.2	10.3	9.0

Cropland Urbanized Coefficients

Cropland urbanized per population increase (*C*) for all 53 study counties was .065 acres per person (table 19). Regionally, the cropland urbanized coefficient ranged from .022 in the South Central Prairie/Woodland Fringe to .148 in the Colorado counties. Acres of cropland taken for urban use per person increase tended to be higher in regions where cropland constituted a proportionally larger share of the land base. Simple regression of percents of regional area in cropland (x) to the regional cropland urbanized coefficients (y) resulted in an r of .78. The correspondence was higher than that between percent of area in cropland and percent of urban development on cropland (r equalled .71) because California's high percentage use of cropland for urban development was partially offset by the high density of such development.

Agricultural land changes have been normalized for population increase in a number of studies. In making comparisons between the present study and other studies, it is again necessary to emphasize that the specifics of calculations varied substantially. A cropland urbanized coefficient of .114 acres per person may be derived from Callahan's study of acreage of open cropland converted to urban uses in six Massachusetts communities from 1940 to 1964.[20] From a study of land use changes in 78 sample towns in New York State, circa 1951 to 1966, a cropland urbanized coefficient of .081 acres per person increase was derived.[21] A *C* value of .108 acres per person was derived in a study of land use change between approximately 1950 and 1960 in 96 Northeastern counties.[22] In the current study, the amount of cropland converted to urban uses per person increase was .052 acres in the five Northeastern counties and .054 acres in the five Middle Atlantic counties. Continued economic abandonment of cropland in these areas has resulted in a smaller cropland base subject to urban development. Higher density of new urban development might also contribute to a declining *C* value. This study's coefficient for cropland urbanized in the California area was fairly close to the .055 acres per person derived from an airphoto study, dominated by California counties, of land use change between approximately 1950 and 1960.[23]

Bogue, in a study of aggregate land use changes between 1924 and 1954 for 147 metropolitan areas associated *all* cropland and pasture decline with population change.[24] He estimated that between .172 and .264 acres of cropland and pasture were lost per person increase. In the current study, over 80 percent of the counties were parts of SMSA's (see footnote 10). Associating, as Bogue did, all cropland and pasture (and range) decline with population increase for the 53 study counties yielded a coefficient of .15 acres decline per person increase. The current study, though, showed that only a quarter of the net cropland loss and 42 percent of the net pasture and range loss was directly to urban uses. Thus, approximately .066 acres of cropland and pasture and range were directly converted to urban use for each person added to the population.

[20] James W. Callahan, *Agricultural Land Use Changes and Population Growth in Six Western Massachusetts Communities, 1940-1965* (College of Agr., Exp. Sta. Bull. 558, Univ. of Mass., 1966).

[21] Allee and others, *Toward the Year 1985*, p. 20.

[22] Dill and Otte, *Urbanization of Land in the Northeastern United States*, p. 4.

[23] Dill and Otte, *Urbanization of Land in the Western States*, pp. 6-7.

[24] Bogue, *Metropolitan Growth and Conversion of Land to Nonagricultural Uses*, p. 14.

Table 19 – Cropland urbanized coefficient (C) and proportion of area in cropland for regional groupings of the 53 study counties

Region	Cropland urbanized coef. (*C*)	Cropland as proportion of total area, earlier period
	Acres per person	*Percent*
Northeast	.052	23.2
Middle Atlantic	.054	28.1
Piedmont	.043	18.1
Appalachian Fringe	.092	37.9
Florida Gulf	.030	10.0
(Jackson Co., Miss.)	(.036)	(2.7)
Corn Belt	.068	48.1
Great Lakes	.111	54.6
South Central Prairie/Woodland Fringe	.022	24.0
Texas Prairie	.098	42.1
Colorado	.148	47.0
California	.068	16.3
53-county total	.065	32.9

Limitations of Coefficients

In this study, land use coefficients were used to rationalize and quantify land use changes. Such coefficients have been widely employed. However, there are limitations to such per capita normalizations. They assume a direct association between population increase and urban land use increase. While in the 53 study counties there was significant urban land use increase, there was no systematic test of the collateral postulate that where urban land uses have increased, population also has evidenced an increase. Results from an identically executed study of land use change in one county – Somerset, Pa. – did suggest that care should be taken when projecting land use change by association with population projections.[25] In Somerset County, which experienced absolute population declines for both 1950 to 1960 and 1960 to 1970, urban land uses increased 21 percent between 1958 and 1967. Residential land increased 10 percent for the same period. This emphasizes the need for further study of land use dynamics in areas experiencing slow or no growth.

TEMPORAL COMPARISON

Land use changes for four counties were observed for two time periods, 1950 to 1960 and 1960 to 1970 (see table 20). Again, it should be emphasized that the smaller the number of counties under consideration, the larger the range of possible error. In generalizing at the county level, accuracy of the data is less reliable than at the multicounty level. However, considering the diversity of the counties which were examined twice, it would be misleading to aggregate their data. Thus, even though the exact quantities are of dubious statistical validity, the direction is at least indicative of land use changes which occurred.

In general, the amount of land consumed per person for urban and residential uses declined during both time periods (table 20). This pattern of increasing density was also evident for the aggregate of the 53 study counties.

In all four counties, the rate of cropland urbanized per person increase *(C)* for the later sample declined from the earlier one, even though the counties had varying patterns of cropland change (table 20). In Prince Georges County, Md., the average net yearly decline in cropland remained about the same. In Dupage County, Ill., yearly net cropland decline for the second interval was almost half that of the first, yet average yearly population increase remained about equal. Clay County, Mo., experiencing a net cropland decline during the first period, had a net increase in cropland for the second interval. Net cropland loss per year in Tarrant County, Tex., was 70 percent higher during the second period. Also in Tarrant, unlike the other counties, the urban land use coefficient was higher for the second period. Yet, in Tarrant County as in the other counties, the amount of cropland taken for urban uses per person increase declined during the second interval.

In three of the counties – Prince Georges, Dupage, and Clay – net conversions of cropland to open idle occurred at a decreasing pace. In Clay County, the pattern of net losses of cropland to open idle was even reversed. However, Tarrant County exhibited the opposite trend. The average net yearly conversions of cropland to open idle was almost four times greater for the later period than for the first interval.

CONCLUSION

Simple comparison of land use inventories of these 53 counties for two time periods indicates that land uses did not change dramatically. Urban uses occupied 3.5 percentage points more of the total area by 1970. Cropland declined by 2.5 percentage points of total area. The percent of total area in pasture and range, open idle, and forest decreased by .3, .5, and .5 points respectively; thus total net decline of these four nonurban uses was 3.8 percentage points. To assume that these losses directly accounted for the increases in urban land would be inaccurate. Only 49 percent of the net cropland decline was to urban use and more new cropland was developed than was lost to urban development. Thus simple comparison of inventories for two points in time masks much of the dynamics of land use change.

Even in these urban areas, shifts among rural uses was an important aspect of land use change. Some new cropland was developed even in areas with rapidly expanding populations. Considering only net moves, the regional patterns of land use change were much more variable than the aggregate. The detailed movements among the various land uses exhibited even more regional differences.

Open idle land use experienced the most dynamism of any of the uses. Cropland and pasture and rangeland were abandoned because of the general changes in farming production and the special negative pressure in urban areas. Yet new cropland and pasture being developed from idle land was almost half as great as the losses to open idle. A significant amount of open idle grew up to forest. Forty percent of the gross acreage diversions of idle land was for urban development. Almost as much land as had remained open idle during the study interval changed to or from open idle use.

[25] This is a fairly common technique used in the previously noted 1956 Bogue study and the 1970 Allee study. Currently, a Land Use Adjustment and Allocation Model which employs per capita data has been developed to estimate the quantity of agricultural land that will be taken from production to accommodate urban and other nonagricultural land needs. This model is a component of the National Assessment Model developed at Iowa State University.

Table 20 – Comparison of land use coefficients for the four counties studied for two time spans

Characteristic	Prince Georges Co., Md.	Dupage Co., Ill.	Clay Co., Mo.	Tarrant Co., Tex.
Average yearly population increase		*1,000 persons*		
Earlier period	19.4	16.2	4.6	17.7
Later period	33.7	17.8	2.7	17.8
		Acres per person		
Urban land use coefficient (U)				
Earlier period	.193	.181	.191	.227
Later period	.099	.082	.082	.253
Residential land use coefficient (R)				
Earlier period	.128	.102	.129	.141
Later period	.073	.037	.165	.128
Cropland urbanized coefficent (C)				
Earlier period	.051	.137	.077	.078
Later period	.026	.064	.021	.059
Average yearly net conversion of cropland to open idle land		*1,000 acres*		
Earlier period	-1.2	-1.4	-.1	-.8
Later period	-1.1	-.7	+.3	-3.1
Average yearly net change in cropland				
Earlier period	-2.3	-3.7	-.3	-2.7
Later period	-2.1	-2.0	+.6	-4.6

During these 10 years of rapid population growth, the 53 counties accounted for 20 percent of the 1960 to 1970 U.S. population increase. The percent of urban land rose from 12.9 to 16.4 percent of the total area. During this time, less land was taken for urban use per person increase in population than had been previously. This trend was also apparent in the examination of land use changes from 1950 to 1960. The actual amount of land urbanized per person increase exhibited considerable geographic variation. There was some indication that the density of urban development, especially for residential use, was higher in areas with higher proportions of cropland. The proportion of urbanized land developed from cropland was greater in areas where cropland occupied more of the land base. The pattern of land use change in the county which had experienced population decline since 1950 suggests that the conversion of land to urban uses in slow or no growth areas should also be the focus of future study.

APPENDIX A–BASIC DATA ON STUDY COUNTIES

State/county	Population[1]		Area[2]	Years of ASCS photography
	1960	1970		
	Thousands		*Square miles*	
Alabama:				
Madison	117.3	186.5	810	1962-1970
California:				
Santa Clara	642.3	1,064.7	1,311	1956-1963
Santa Cruz	84.2	123.8	440	1956-1963
Colorado:				
Adams	120.3	185.8	1,242	1957-1969
Arapahoe	113.4	162.1	802	1956-1969
Florida:				
Lee	54.5	105.2	1,005	1958-1970
Pasco	36.8	76.0	772	1957-1968
Sarasota	76.9	120.4	620	1957-1969
Georgia:				
Cobb	114.2	196.8	348	1960-1972
Dekalb	256.8	415.4	269	1960-1972
Illinois:				
Dupage[3]	313.5	491.9	331	1954-1961-1967
Lake	293.7	382.6	474	1961-1967
Will	191.6	249.5	853	1961-1967
Indiana:				
Monroe	59.2	84.8	412	1954-1967
Porter	60.3	87.1	425	1958-1965
Kansas:				
Johnson	143.8	217.7	478	1959-1966
Kentucky:				
Fayette	131.9	174.3	281	1960-1966
Maryland:				
Harford	76.7	115.4	475	1964-1971
Howard	36.2	61.9	251	1964-1970
Montgomery	340.9	522.8	505	1963-1970
Prince Georges[3]	357.4	660.6	497	1957-1963-1970
Massachusetts:				
Plymouth	248.4	333.3	710	1952-1970
Michigan:				
Macomb	405.8	625.0	481	1964-1973
Washtenaw	172.4	234.1	723	1963-1969
Minnesota:				
Anoka	85.9	154.6	443	1964-1970
Dakota	78.3	139.8	588	1964-1970
Washington	52.4	82.9	419	1964-1970
Mississippi:				
Jackson	55.5	88.0	761	1958-1970

See footnotes at end of table

Continued

Basic data on study counties, Continued

State/county	Population[1]		Area[2]	Years of ASCS photography
	1960	1970		
	Thousands		*Square miles*	
Missouri:				
Boone	55.2	80.9	689	1956-1968
Clay[3]	87.5	123.3	417	1952-1963-1973
Jefferson	66.4	105.3	671	1959-1966
St. Charles	53.0	93.0	586	1958-1971
St. Louis	703.5	951.4	517	1965-1971
Nebraska:				
Sarpy	31.3	63.7	248	1965-1971
New Jersey:				
Burlington	224.5	323.1	830	1963-1970
Monmouth	334.4	459.4	487	1963-1970
Morris	261.6	383.5	478	1963-1971
Sussex	49.3	77.5	538	1963-1970
North Carolina:				
Cumberland	148.4	212.0	655	1960-1972
Mecklenburg	272.1	354.7	552	1961-1968
Wake	169.1	228.5	859	1959-1971
Ohio:				
Portage	91.8	125.9	506	1966-1972
Oklahoma:				
Cleveland	47.6	81.8	559	1963-1969
Pennsylvania:				
Bucks	308.6	415.1	625	1964-1971
Chester	210.6	278.3	762	1964-1971
Somerset[4]	77.4	76.0	1,078	1958-1967
Texas:				
Collin	41.2	66.9	886	1964-1972
Dallas	951.5	1,327.3	902	1964-1972
Denton	47.3	75.6	958	1964-1972
Harris	1,243.2	1,741.9	1,766	1964-1973
Tarrant[3]	538.5	716.3	898	1950-1963-1970
Travis	212.1	295.5	1,047	1964-1973
Virginia:				
Henrico	117.3	154.4	234	1965-1972
Wisconsin:				
Waukeska	158.2	231.4	580	1963-1969

[1] U.S. Dept. Commerce, Census of Population.
[2] Dept. Commerce, Census Bureau Area Measurement Reports.
[3] Land use changes documented for 2 time periods.
[4] Generally excluded from comparisons.

APPENDIX B – METHODOLOGY

Sample Selection

The purpose of the photo interpretation was to extract certain data from airphotos to measure land use over a decade in both urban and rural areas of selected counties that expericenced rapid population growth. Counties that had a 30-percent population increase and an absolute population increase of 20,000 between 1960 and 1970 were listed. From these, 53 were selected that had complete airphoto coverage for 2 recent years approximating a 10-year interval. Ideally, photography

for the 2 years would have been 1960 and 1970 so that the period of observed land use change would coincide with the most recent censuses of population.

Comparable scale of photography provided greater economy and enhanced interpretation quality by permitting development of procedures which could be uniformly and repetitively applied. Therefore, ASCS photography was used. ASCS obtains aerial photography for use in monitoring various farm programs; therefore, almost all cropland has been covered. Thus, selection of study counties was biased toward agriculturally more important counties. While limiting the source to ASCS photography simplified the interpretation and sampling procedures, it had an important disadvantage for the analysis. An area is rephotographed when significant changes in the cropland acreages and field boundaries have occurred – on the average at intervals of 8 years. In the study counties, ASCS photography did not correspond exactly to census dates and the intervals were usually not 10 years.

Sampling Technique

The land use and land use change information was obtained through two sampling steps, the first a 10-percent photographic sample of the county area, the second a random point sample on the selected photos covering a tenth of a county's area. The 10-percent photo sample was selected systematically, as simple random sampling could result in clustering of photos in rural or urban areas. However, selection of the first photograph in each county was randomized within certain constraints. The aim for a 10-percent coverage of the sample area was substantially exceeded as approximately 15 percent of the area was subject to the second step, the point sample. A random point sample of 20 points per square mile performed on the 15-percent sample of total county area yielded an expanded sample rate for the study areas of 3 points per square mile.

Land Use Categories

The 12 categories selected covered most possibilities of urban and rural uses of land. Brief working definitions and descriptions are given below:

Cropland was identified by its even tone and texture. On occasion, distinct row patterns could be seen. Cropland was also definable by a lack of natural vegetation, by sharply defined boundaries, by field access roads, and in some cases by machine tracks leading to the field.

Pasture and range included land with up to 30-percent crown cover that showed unmistakable signs of animal use such as stock ponds, animal trails, and salt licks. It usually lacked the appearance of recent tillage and often had a regular shape with distinct boundaries. Some of these indicators were not readily evident in extensively managed rangelands.

Open idle land was defined as land having less than 10-percent crown cover and no evidence of other use. Photographically, it appeared uneven in texture and tone, was often irregular in shape, and commonly had uneven shrubby vegetation. Tidal flats were included in this category.

Farmsteads included all farm buildings and farm activity with the exception of the farm residence and associated yards. Barns, silos, machinery sheds, exercise yards, watering points, feed lots, etc. were part of this category.

Forest lands were defined as having more than 10-percent crown cover and no other visible uses. Also included were areas of less than 10-percent cover showing evidence of logging.

Residential category consisted of houses and the yards associated with them including farm and rural dwellings, apartment complexes, mobile home sites, and streets within urban residential areas.

Urban idle included moderate to small unused tracts surrounded on three sides by urban activity. Construction sites where intended use could not be determined were considered in this category.

Transportation comprised facilities and land areas associated with the movements of people and goods. Included were all highways and roads (except streets within residential areas), railroad lines and yards, clearly distinguishable rights-of-way, airports, and docks.

Recreation predominately consisted of man-made outdoor facilities generally associated with resident population. Camp grounds, golf courses, drive-in theatres, race tracks, ski facilities, and public swimming pools were typical of this category. Forest cover may have obscured some of these uses.

Commercial-industrial-institutional was a broad category. It included the structures and ground obviously associated with these uses such as central business districts, stores, car lots, utilities, factories, schools, and cemeteries.

Water bodies greater than 40 acres included all reservoirs and lakes greater than 40 acres and streams or rivers wider than 200 feet from bank to bank. This definition corresponded to that used in the Department of Commerce Census of Areas.

Miscellaneous consisted primarily of streams, bodies of water less than 40 acres, nonforested wetlands, drainage ditches, irrigation ditches, and Government grain storage bins. Inclusion in this class was minimized to avoid the excessive use of a category which provides minimum information.

Areal Calculations

The point sample data were converted to acreages by dividing each county's area, as obtained from census

publications and correspondence, by the total number of points interpreted for that county.[1] Thus, for each county, a point had a specific acre equivalent, which provided the constant for conversions of point data to acreage data for that county.

Data Summation

The intricacy of the land use transition matrix made it extremely difficult to compute change on a yearly basis. Thus, to combine multicounty data, acreages for each interval were summed. However, this introduced a bias, weighing more heavily the changes in counties with a longer interval between sample years. In deriving the land use change coefficients, it was possible to employ yearly change for both population and land use. Yearly population change was obtained by deriving a population figure for each county for its particular photo years. To calculate population for each photo year, the following were used when appropriate: decennial censuses of population, interdecade estimates published by the Census Bureau for 1966 and 1971-73, estimates supplied by individual counties, and interpolation where necessary. Land use coefficients were then calculated by dividing the average yearly change in land use by the average yearly change in population.

Sample Error

This study involved generation of primary data and then making generalizations from the data. Accuracy of this data must, therefore, be considered. The air photo interpretation procedure employed to generate this study's data involved a two-step sample, the 15-percent print sample and, within that, a point sample. To calculate sample error, account must be taken of error potentially introduced in each step of the sampling process. To do this, the sample error for each land use, expressed as the coefficient of variation (*c.v.*) may be calculated as follows:*

$$*c.v.\left(\hat{\bar{y}}\right) = \frac{\sqrt{v\left(\hat{\bar{y}}\right)}}{\hat{\bar{y}}} \qquad \hat{\bar{y}} = \frac{1}{n}\sum^{n} M_i p_i$$

$$v\left(\hat{\bar{y}}\right) = \frac{\left(1-\frac{n}{N}\right)\sum^{n}\left(M_i p_i - \frac{\sum^{n} M_i p_i}{n}\right)^2}{n(n-1)} + \frac{1}{nN}\sum^{n}\frac{M_i p_i (1-p_i)}{(m_i - 1)}$$

where: N = Total number of prints in counties

n = Number of sampled prints in counties

M_i = Total number of points in *ith* print

m_i = Number of sampled points on *ith* print

p_i = Proportion of points in specified land use on *ith* print based on sample

$\hat{\bar{y}}$ = Estimated average number of points in specified land use per print.

The degree of sample error depends on both the magnitude and extent of dispersion of a land use's occurrence. For illustration, the *c.v.'s* for each 1970 land use for the group of 11 Corn Belt counties is shown in App. B table 1. In the Corn Belt group, cropland exhibits the least sample error due to its ubiquity, dispersed pattern, and the fact that it constitutes a high proportion of all land uses. On the other hand, the urban idle measurement is subject to the largest inaccuracies because of the small acreage of land involved and its localized distribution. Thus, the larger the sample and/or the greater prevalence of a certain use, the smaller the sample error should be. Sample error will also be less for uses more evenly spatially distributed. Therefore, generalizations are more valid when they are based on multiple county data and/or areally more important uses. Conclusions based on observed changes within the cells of the land transition matrices are less reliable than the aggregate 1961 and 1970 inventories because each cell describes changes for a smaller, more localized proportion of the sample.

Appendix B table 1–Estimated accuracy of two-step point sample of land use for the Corn Belt counties, 1970

Land use	Acreage	Prevalence	Coefficient of variation
	1,000 acres	*Percent*	*Percent*
Cropland	1690.8	46.4	5.4
Pasture and range	99.8	2.7	10.9
Farmstead	49.7	1.4	9.0
Open idle	248.5	6.8	8.1
Forest	799.6	21.9	7.9
Residential	319.6	8.8	14.2
Urban idle	12.6	.3	33.3
Transportation	156.3	4.3	7.5
Recreation	20.0	.5	20.8
Commercial-industrial-institutional	96.8	2.7	17.5
Water bodies over 40 acres	89.6	2.5	20.3
Miscellaneous	57.6	1.6	8.2

[1] U.S. Department of Commerce, *Census Bureau Area Measurement Reports*, GE-20 Series, for each State for 1960 were used except where correspondence with the Census Bureau indicated corrections or changes had occurred.

* Adapted by H. F. Huddleston, Stat. Rptg. Serv., USDA, Washington, D.C. See H. F. Huddleston, "Point Sampling Surveys for Potato Acreage in Colorado's San Luis Valley," *Ag. Econ. Res.*, Vol. 20, No. 1, Jan. 1968, pp. 1-4, and W. A. Hendricks, *The Mathematical Theory of Sampling* (Scarecrow Press, New Brunswick, N.J., 1956) pp. 183-186, 206-208.

APPENDIX C--TRANSITION MATRICES

Appendix C table 1--Land use transition matrix for the 53 study counties

1961 land uses	1970 land uses												
	Cropland	Pasture and range	Open idle	Farm-steads	Forest	Residen-tial	Urban idle	Transpor-tation	Recrea-tion	Comm.-Ind.-Inst. 1/	Water bodies	Miscel-laneous	1961 totals
	Acres												
Cropland	6357823.	106413.	362263.	2362.	48231.	150343.	2302.	44841.	13656.	55356.	19498.	6421.	7169509.
Pasture and range	107748.	1516938.	99275.	0.	18020.	11665.	0.	6851.	3145.	4960.	1464.	1416.	1771482.
Open idle	127572.	69749.	1389025.	1921.	175259.	152483.	1851.	22483.	10231.	65390.	32298.	12489.	2060751.
Farmsteads	1564.	196.	2410.	185227.	235.	841.	0.	579.	0.	1674.	0.	0.	192730.
Forest	26369.	13928.	73759.	1570.	6308584.	143586.	1482.	32876.	5581.	32019.	8765.	3495.	6652013.
Residential	0.	0.	1189.	0.	216.	1435118.	0.	2139.	0.	1595.	0.	0.	1440257.
Urban idle	0.	0.	0.	0.	0.	16990.	49145.	1944.	969.	11586.	0.	0.	80634.
Transportation	0.	0.	0.	0.	0.	0.	0.	778371.	1096.	0.	346.	0.	779813.
Recreation	0.	0.	0.	0.	0.	228.	0.	346.	111655.	196.	0.	0.	112425.
Comm.-Ind.-Inst. 1/	0.	0.	8078.	0.	0.	0.	0.	0.	0.	380681.	0.	173.	388932.
Water bodies over 40 acres	0.	0.	6841.	0.	434.	696.	0.	0.	248.	0.	645418.	0.	653637.
Miscellaneous	5254.	696.	13824.	0.	1037.	2221.	0.	1960.	236.	232.	2895.	433981.	462336.
1970 totals	6626333.	1707920.	1956664.	191080.	6552016.	1914171.	54780.	892390.	146817.	553689.	710684.	457975.	21764518.

1/ Commercial-industrial-institutional

Appendix C table 2--Land use transition matrix for Northeast regional group

1961 land uses	1970 land uses												
	Cropland	Pasture and range	Open idle	Farm-steads	Forest	Residen-tial	Urban idle	Transpor-tation	Recrea-tion	Comm.-Ind.-Inst. 1/	Water bodies	Miscel-laneous	1961 totals
	Acres												
Cropland	573575.	1579.	53312.	0.	3348.	14080.	0.	1731.	2556.	7103.	0.	235.	657519.
Pasture and range	627.	21939.	2986.	0.	602.	966.	0.	0.	0.	0.	0.	221.	27341.
Open idle	3831.	217.	174102.	0.	14674.	14718.	0.	2477.	425.	5678.	433.	654.	217209.
Farmsteads	0.	196.	203.	13167.	0.	196.	0.	0.	0.	222.	0.	0.	13984.
Forest	628.	0.	7621.	0.	1269614.	29393.	188.	8206.	1218.	10740.	0.	0.	1327608.
Residential	0.	0.	0.	0.	0.	256433.	0.	0.	0.	0.	0.	0.	256433.
Urban idle	0.	0.	0.	0.	0.	188.	3005.	565.	0.	819.	0.	0.	4577.
Transportation	0.	0.	0.	0.	0.	0.	0.	110052.	0.	0.	0.	0.	110052.
Recreation	0.	0.	0.	0.	0.	0.	0.	0.	16248.	196.	0.	0.	16444.
Comm.-Ind.-Inst. 1/	0.	0.	188.	0.	0.	0.	0.	0.	0.	62757.	0.	0.	62945.
Water bodies over 40 acres	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	93609.	0.	93609.
Miscellaneous	0.	0.	217.	0.	0.	0.	0.	0.	0.	0.	0.	47254.	47471.
1970 totals	578661.	23931.	238629.	13167.	1288238.	315974.	3193.	123031.	20447.	87515.	94042.	48364.	2835191.

1/ Commercial-industrial-institutional

Appendix C table 3--Land use transition matrix for the Middle Atlantic regional group

1961 land uses	1970 land uses												
	Cropland	Pasture and range	Open idle	Farm-steads	Forest	Residen-tial	Urban idle	Transpor-tation	Recrea-tion	Comm.- 1/ Ind.- Inst.	Water bodies	Miscel-laneous	1961 totals
	Acres												
Cropland	296298.	3644.	29070.	229.	867.	17209.	0.	2662.	1935.	1751.	0.	414.	354104.
Pasture and range	3644.	28642.	3625.	0.	427.	280.	0.	0.	0.	0.	0.	213.	36831.
Open idle	2490.	105.	45745.	0.	15482.	13865.	0.	1698.	0.	3898.	229.	280.	83872.
Farmsteads	0.	0.	0.	12220.	0.	0.	0.	0.	0.	742.	0.	0.	12962.
Forest	0.	0.	3825.	0.	526524.	11566.	0.	2614.	465.	1340.	0.	211.	546545.
Residential	0.	0.	229.	0.	0.	108768.	0.	422.	0.	229.	0.	0.	109648.
Urban idle	0.	0.	0.	0.	0.	211.	1194.	0.	0.	633.	0.	0.	2038.
Transportation	0.	0.	0.	0.	0.	0.	0.	47613.	0.	0.	0.	0.	47613.
Recreation	0.	0.	0.	0.	0.	0.	0.	0.	10190.	0.	0.	0.	10190.
Comm.-Ind.-Inst. 1/	0.	0.	0.	0.	0.	0.	0.	0.	0.	26295.	0.	0.	26295.
Water bodies over 40 acres	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	22419.	0.	22419.
Miscellaneous	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	3154.	3154.
1970 totals	302432.	32496.	82494.	12449.	543300.	151899.	1194.	55009.	12590.	34888.	22648.	4272.	1255670.

1/ Commercial-industrial-institutional

Appendix C table 4--Land use transition matrix for the Piedmont regional group

1961 land uses	1970 land uses												
	Cropland	Pasture and range	Open idle	Farm-steads	Forest	Residen-tial	Urban idle	Transpor-tation	Recrea-tion	Comm.-Ind.-Inst. 1/	Water bodies	Miscel-laneous	1961 totals
	Acres												
Cropland	232036.	3040.	23391.	0.	29628.	15399.	0.	1041.	1589.	2130.	681.	1042.	309977.
Pasture and range	415.	3389.	631.	0.	2532.	0.	0.	0.	0.	0.	0.	0.	6967.
Open idle	4245.	0.	46443.	0.	35567.	12885.	0.	3152.	227.	8187.	15649.	523.	126878.
Farmsteads	0.	0.	0.	7137.	0.	0.	0.	0.	0.	0.	0.	0.	7137.
Forest	2958.	207.	19577.	210.	906331.	40978.	891.	8166.	1101.	8822.	3784.	1375.	994400.
Residential	0.	0.	316.	0.	0.	103071.	0.	454.	0.	0.	0.	0.	103841.
Urban idle	0.	0.	0.	0.	0.	227.	1910.	0.	0.	1507.	0.	0.	3644.
Transportation	0.	0.	0.	0.	0.	0.	0.	89663.	0.	0.	0.	0.	89663.
Recreation	0.	0.	0.	0.	0.	0.	0.	0.	6215.	0.	0.	0.	6215.
Comm.-Ind.-Inst. 1/	0.	0.	437.	0.	0.	0.	0.	0.	0.	30967.	0.	0.	31404.
Water bodies over 40 acres	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	13579.	0.	13579.
Miscellaneous	210.	0.	210.	0.	0.	316.	0.	0.	0.	0.	0.	22672.	23408.
1970 totals	239864.	6636.	91005.	7347.	974058.	172876.	2801.	102476.	9132.	51613.	33693.	25612.	1717112.

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Appendix C table 5--Land use transition matrix for the Appalachian Fringe regional group

1961 land uses	1970 land uses												
	Cropland	Pasture and range	Open idle	Farm-steads	Forest	Residen-tial	Urban idle	Transpor-tation	Recrea-tion	Comm.- 1/ Ind.-Inst.	Water bodies	Miscel-laneous	1961 totals
	Acres												
Cropland	433760.	6323.	21671.	0.	2605.	7915.	0.	1142.	474.	2135.	11351.	472.	487848.
Pasture and range	4885.	47283.	6027.	0.	1661.	0.	0.	285.	236.	238.	0.	0.	60615.
Open idle	9933.	807.	50152.	0.	13279.	8671.	0.	807.	711.	5927.	709.	0.	90996.
Farmsteads	236.	0.	0.	16403.	0.	0.	0.	0.	0.	0.	0.	0.	16639.
Forest	946.	710.	2373.	0.	439833.	3081.	0.	472.	951.	951.	709.	236.	450262.
Residential	0.	0.	0.	0.	0.	75811.	0.	285.	0.	0.	0.	0.	75896.
Urban idle	0.	0.	0.	0.	0.	946.	1418.	0.	0.	474.	0.	0.	2838.
Transportation	0.	0.	0.	0.	0.	0.	0.	42363.	709.	0.	0.	0.	43072.
Recreation	0.	0.	0.	0.	0.	0.	0.	0.	6124.	0.	0.	0.	6124.
Comm.-Ind.-Inst. 1/	0.	0.	472.	0.	0.	0.	0.	0.	0.	23648.	0.	0.	24120.
Water bodies over 40 acres	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	11047.	0.	11047.
Miscellaneous	0.	0.	0.	0.	0.	0.	0.	0.	236.	0.	1904.	14139.	16279.
1970 totals	449760.	55123.	80695.	16403.	457378.	96224.	1418.	45354.	9441.	33373.	25720.	14847.	1285735.

1/ Commercial-industrial-institutional

Appendix C table 6--Land use transition matrix for the Florida Gulf regional group

1961 land uses	1970 land uses												
	Cropland	Pasture and range	Open idle	Farm-steads	Forest	Residen-tial	Urban idle	Transpor-tation	Recrea-tion	Comm.-Ind.-Inst. 1/	Water bodies	Miscel-laneous	1961 totals
	Acres												
Cropland	128460.	5104.	10650.	866.	4174.	2414.	0.	887.	464.	212.	0.	212.	153443.
Pasture and range	26050.	79253.	7384.	0.	5204.	2964.	0.	908.	2320.	232.	0.	0.	124315.
Open idle	45285.	17322.	277213.	1268.	55015.	30255.	0.	5376.	849.	2605.	0.	5540.	440728.
Farmsteads	170.	0.	232.	3192.	0.	0.	0.	0.	0.	0.	0.	0.	3594.
Forest	13298.	5908.	10263.	928.	367495.	6938.	0.	2878.	0.	572.	0.	212.	408492.
Residential	0.	0.	0.	0.	0.	31637.	0.	0.	0.	170.	0.	0.	31807.
Urban idle	0.	0.	0.	0.	0.	509.	340.	0.	0.	0.	0.	0.	849.
Transportation	0.	0.	0.	0.	0.	0.	0.	32261.	0.	0.	0.	0.	32261.
Recreation	0.	0.	0.	0.	0.	0.	0.	0.	2037.	0.	0.	0.	2037.
Comm.-Ind.-Inst. 1/	0.	0.	0.	0.	0.	0.	0.	0.	0.	5398.	0.	0.	5398.
Water bodies over 40 acres	0.	0.	2026.	0.	0.	696.	0.	0.	0.	0.	189472.	0.	192194.
Miscellaneous	4658.	696.	12803.	0.	1037.	1905.	0.	1291.	0.	232.	0.	116422.	139044.
1970 totals	217921.	108283.	320571.	6254.	432925.	77318.	340.	43601.	5670.	9421.	189472.	122386.	1534161.

1/ Commercial-industrial-institutional

Appendix C table 7--Land use transition matrix for Jackson County, Mississippi

1961 land uses	1970 land uses												
	Cropland	Pasture and range	Open idle	Farm-steads	Forest	Residen-tial	Urban idle	Transpor-tation	Recrea-tion	Comm.-Ind.-Inst. 1/	Water bodies	Miscel-laneous	1961 totals
	Acres												
Cropland	8436.	0.	1554.	0.	1776.	1332.	0.	0.	0.	0.	0.	0.	13098.
Pasture and range	0.	0.	0.	0.	1110.	0.	0.	0.	0.	0.	0.	0.	1110.
Open idle	2442.	0.	56385.	0.	9323.	1776.	0.	444.	0.	1110.	0.	222.	71702.
Farmsteads	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Forest	2220.	0.	5772.	0.	335201.	5550.	0.	1776.	0.	1776.	0.	222.	352517.
Residential	0.	0.	0.	0.	0.	11321.	0.	0.	0.	0.	0.	0.	11321.
Urban idle	0.	0.	0.	0.	0.	222.	222.	0.	0.	0.	0.	0.	444.
Transportation	0.	0.	0.	0.	0.	0.	0.	5994.	0.	0.	0.	0.	5994.
Recreation	0.	0.	0.	0.	0.	0.	0.	0.	888.	0.	0.	0.	888.
Comm.-Ind.-Inst. 1/	0.	0.	0.	0.	0.	0.	0.	0.	0.	1776.	0.	0.	1776.
Water bodies over 40 acres	0.	0.	1998.	0.	0.	0.	0.	0.	0.	0.	20867.	0.	22865.
Miscellaneous	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	5328.	5328.
1970 totals	13098.	0.	65709.	0.	347410.	20201.	222.	8214.	888.	4662.	20867.	5772.	487043.

1/ Commercial-industrial-institutional

Appendix C table 8--Land use transition matrix for the Corn Belt regional group

1961 land uses	1970 land uses												
	Cropland	Pasture and range	Open idle	Farm-steads	Forest	Residen-tial	Urban idle	Transpor-tation	Recrea-tion	Comm.- 1/ Ind.- Inst.	Water bodies	Miscel-laneous	1961 totals
	Acres												
Cropland	1646415.	13916.	51825.	278.	3660.	25079.	453.	3483.	1251.	9476.	216.	1745.	1757797.
Pasture and range	17549.	81600.	16715.	0.	2598.	248.	0.	216.	0.	0.	0.	0.	119016.
Open idle	21667.	3961.	169170.	222.	18848.	19504.	0.	1394.	0.	9216.	864.	2597.	247443.
Farmsteads	653.	0.	214.	48776.	0.	237.	0.	0.	0.	0.	0.	0.	49880.
Forest	4314.	257.	7582.	432.	773812.	4247.	228.	1947.	257.	3330.	651.	607.	797664.
Residential	0.	0.	0.	0.	216.	265550.	0.	432.	0.	620.	0.	0.	266818.
Urban idle	0.	0.	0.	0.	0.	4537.	11961.	1204.	556.	2332.	0.	0.	20590.
Transportation	0.	0.	0.	0.	0.	0.	0.	147592.	214.	0.	0.	0.	147806.
Recreation	0.	0.	0.	0.	0.	228.	0.	0.	17472.	0.	0.	0.	17700.
Comm.-Ind.-Inst. 1/	0.	0.	464.	0.	0.	0.	0.	0.	0.	71792.	0.	0.	72256.
Water bodies over 40 acres	0.	0.	1984.	0.	434.	0.	0.	0.	248.	0.	87895.	0.	90561.
Miscellaneous	186.	0.	594.	0.	0.	0.	0.	0.	0.	0.	0.	52645.	53425.
1970 totals	1690784.	99824.	248548.	49708.	799568.	319630.	12642.	156268.	19998.	96766.	89626.	57594.	3640955.

1/ Commercial-industrial-institutional

Appendix C table 9--Land use transition matrix for the Great Lakes regional group

1961 land uses	1970 land uses												
	Cropland	Pasture and range	Open idle	Farm-steads	Forest	Residen-tial	Urban idle	Transpor-tation	Recrea-tion	Comm.- 1/ Ind.- Inst.	Water bodies	Miscel-laneous	1961 totals
	Acres												
Cropland	1026430.	5257.	61077.	283.	979.	11589.	616.	8996.	3118.	10462.	0.	509.	1129316.
Pasture and range	3224.	27893.	8897.	0.	226.	227.	0.	455.	0.	850.	0.	0.	41772.
Open idle	5611.	1227.	149110.	0.	6087.	5916.	0.	2365.	616.	2437.	0.	0.	173369.
Farmsteads	509.	0.	0.	34253.	0.	0.	0.	175.	0.	0.	0.	0.	34937.
Forest	1321.	401.	3838.	0.	363875.	4585.	175.	1922.	0.	1593.	0.	226.	377936.
Residential	0.	0.	0.	0.	0.	100995.	0.	200.	0.	0.	0.	0.	101195.
Urban idle	0.	0.	0.	0.	0.	1183.	1365.	175.	0.	616.	0.	0.	3339.
Transportation	0.	0.	0.	0.	0.	0.	0.	76866.	0.	0.	0.	0.	76866.
Recreation	0.	0.	0.	0.	0.	0.	0.	0.	23382.	0.	0.	0.	23382.
Comm.-Ind.-Inst. 1/	0.	0.	2268.	0.	0.	0.	0.	0.	0.	21066.	0.	0.	23334.
Water bodies over 40 acres	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	54536.	0.	54536.
Miscellaneous	200.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	29569.	29769.
1970 totals	1037295.	34778.	225190.	34536.	371167.	124495.	2156.	91154.	27116.	37024.	54536.	30304.	2069750.

1/ Commercial-industrial-institutional

Appendix C table 10--Land use transition matrix for the South Central Prairie/Woodland Fringe regional group

1961 land uses	1970 land uses												
	Cropland	Pasture and range	Open idle	Farm-steads	Forest	Residen-tial	Urban idle	Transpor-tation	Recrea-tion	Comm.- Ind.- Inst. 1/	Water bodies	Miscel-laneous	1961 totals
	Acres												
Cropland	441120.	15501.	44349.	0.	801.	8445.	196.	393.	0.	3802.	4215.	0.	518822.
Pasture and range	7355.	367513.	28101.	0.	3660.	1837.	0.	605.	0.	1571.	1274.	196.	412112.
Open idle	847.	212.	122867.	196.	4428.	25794.	0.	785.	1474.	7252.	9062.	589.	173506.
Farmsteads	0.	0.	425.	15139.	0.	0.	0.	0.	0.	0.	0.	0.	15564.
Forest	212.	3812.	5865.	0.	569917.	28951.	0.	2925.	421.	2356.	0.	0.	614459.
Residential	0.	0.	0.	0.	0.	192322.	0.	0.	0.	0.	0.	0.	192322.
Urban idle	0.	0.	0.	0.	0.	4320.	6886.	0.	0.	1375.	0.	0.	12581.
Transportation	0.	0.	0.	0.	0.	0.	0.	73212.	0.	0.	0.	0.	73212.
Recreation	0.	0.	0.	0.	0.	0.	0.	0.	10365.	0.	0.	0.	10365.
Comm.-Ind.-Inst. 1/	0.	0.	0.	0.	0.	0.	0.	0.	0.	57200.	0.	0.	57200.
Water bodies over 40 acres	0.	0.	637.	0.	0.	0.	0.	0.	0.	0.	48435.	0.	49072.
Miscellaneous	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	425.	28246.	28671.
1970 totals	449534.	387038.	202244.	15335.	578806.	261669.	7082.	77920.	12260.	73556.	63411.	29031.	2157885.

1/ Commercial-industrial-institutional

Appendix C table 11--Land use transition matrix for the Texas Prairie regional group

1961 land uses	1970 land uses												
	Cropland	Pasture and range	Open idle	Farm-steads	Forest	Residen-tial	Urban idle	Transpor-tation	Recrea-tion	Comm.- 1/ Ind.- Inst.	Water bodies	Miscel-laneous	1961 totals
	Acres												
Cropland	871924.	26553.	40711.	231.	0.	16525.	1037.	18639.	346.	9659.	3035.	570.	989230.
Pasture and range	7600.	436828.	6292.	0.	0.	3768.	0.	2766.	0.	1676.	190.	546.	459666.
Open idle	3602.	1593.	108102.	0.	0.	10855.	1851.	2197.	4810.	8744.	4393.	1451.	147598.
Farmsteads	0.	0.	943.	24438.	0.	173.	0.	404.	0.	231.	0.	0.	26189.
Forest	231.	1486.	5878.	0.	177359.	8101.	0.	1558.	519.	539.	1458.	190.	197319.
Residential	0.	0.	404.	0.	0.	222276.	0.	346.	0.	183.	0.	0.	223209.
Urban idle	0.	0.	0.	0.	0.	3981.	18882.	0.	173.	2455.	0.	0.	25491.
Transportation	0.	0.	0.	0.	0.	0.	0.	93536.	173.	0.	346.	0.	94055.
Recreation	0.	0.	0.	0.	0.	0.	0.	346.	9190.	0.	0.	0.	9536.
Comm.-Ind.-Inst. 1/	0.	0.	173.	0.	0.	0.	0.	0.	0.	54087.	0.	173.	54433.
Water bodies over 40 acres	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	60909.	0.	60909.
Miscellaneous	0.	0.	0.	0.	0.	0.	0.	190.	0.	0.	173.	64163.	64526.
1970 totals	883357.	466460.	162503.	24669.	177359.	265679.	21770.	119982.	15211.	77574.	70504.	67093.	2352160.

1/ Commercial-industrial-institutional

Appendix C table 12--Land use transition matrix for the Colorado regional group

1961 land uses	1970 land uses												
	Cropland	Pasture and range	Open idle	Farm-steads	Forest	Residen-tial	Urban idle	Transpor-tation	Recrea-tion	Comm.- 1/ Ind.- Inst.	Water bodies	Miscel-laneous	1961 totals
	Acres												
Cropland	558493.	21444.	12824.	475.	0.	12733.	0.	4492.	941.	3596.	0.	240.	615238.
Pasture and range	35966.	242585.	14194.	0.	0.	0.	0.	1420.	0.	0.	0.	240.	294405.
Open idle	25968.	43360.	159791.	235.	0.	6377.	0.	1199.	470.	6604.	959.	240.	245203.
Farmsteads	0.	0.	0.	6907.	235.	235.	0.	0.	0.	479.	0.	0.	7856.
Forest	240.	714.	949.	0.	7373.	0.	0.	0.	0.	0.	0.	0.	9276.
Residential	0.	0.	240.	0.	0.	17962.	0.	0.	0.	0.	0.	0.	18202.
Urban idle	0.	0.	0.	0.	0.	470.	1176.	0.	240.	0.	0.	0.	1886.
Transportation	0.	0.	0.	0.	0.	0.	0.	37408.	0.	0.	0.	0.	37408.
Recreation	0.	0.	0.	0.	0.	0.	0.	0.	3062.	0.	0.	0.	3062.
Comm.-Ind.-Inst. 1/	0.	0.	4076.	0.	0.	0.	0.	0.	0.	15678.	0.	0.	19754.
Water bodies over 40 acres	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	14982.	0.	14982.
Miscellaneous	0.	0.	0.	0.	0.	0.	0.	479.	0.	0.	0.	40213.	40692.
1970 totals	620667.	308103.	192074.	7617.	7608.	37777.	1176.	44998.	4713.	26357.	15941.	40933.	1307963.

1/ Commercial-industrial-institutional

Appendix C table 13--Land use transition matrix for the California regional group

1961 land uses	1970 land uses												
	Cropland	Pasture and range	Open idle	Farm-steads	Forest	Residen-tial	Urban idle	Transpor-tation	Recrea-tion	Comm.-Ind.-Inst. 1/	Water bodies	Miscel-laneous	1961 totals
	Acres												
Cropland	140878.	4027.	11829.	0.	393.	17623.	0.	1375.	982.	5030.	0.	982.	183119.
Pasture and range	433.	179924.	4423.	0.	0.	1375.	0.	196.	589.	393.	0.	0.	187333.
Open idle	1651.	865.	29946.	0.	2556.	1867.	0.	589.	649.	3732.	0.	393.	42248.
Farmsteads	0.	0.	393.	3595.	0.	0.	0.	0.	0.	0.	0.	0.	3988.
Forest	0.	433.	216.	0.	571253.	196.	0.	412.	649.	0.	2163.	216.	575538.
Residential	0.	0.	0.	0.	0.	49173.	0.	0.	0.	393.	0.	0.	49566.
Urban idle	0.	0.	0.	0.	0.	196.	786.	0.	0.	1375.	0.	0.	2357.
Transportation	0.	0.	0.	0.	0.	0.	0.	21811.	0.	0.	0.	0.	21811.
Recreation	0.	0.	0.	0.	0.	0.	0.	0.	6482.	0.	0.	0.	6482.
Comm.-Ind.-Inst. 1/	0.	0.	0.	0.	0.	0.	0.	0.	0.	10017.	0.	0.	10017.
Water bodies over 40 acres	0.	0.	196.	0.	0.	0.	0.	0.	0.	0.	27668.	0.	27864.
Miscellaneous	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	393.	10176.	10569.
1970 totals	142962.	185249.	47003.	3595.	574202.	70430.	786.	24383.	9351.	20940.	30224.	11767.	1120892.

1/ Commercial-industrial-institutional

Appendix C table 14--Land use transition matrix for Group I, NON SMSA county group

1961 land uses	1970 land uses												
	Cropland	Pasture and range	Open idle	Farm-steads	Forest	Residen-tial	Urban idle	Transpor-tation	Recrea-tion	Comm.-Ind.-Inst. 1/	Water bodies	Miscel-laneous	1961 totals
	Acres												
Cropland	251830.	6854.	31006.	866.	5593.	9875.	0.	887.	464.	1510.	11351.	212.	320448.
Pasture and range	26483.	118411.	14292.	0.	5440.	2964.	0.	908.	2556.	232.	0.	0.	171286.
Open idle	47273.	18404.	329219.	1268.	61808.	35473.	0.	5612.	1498.	4220.	1142.	5973.	511890.
Farmsteads	170.	0.	232.	6816.	0.	0.	0.	0.	0.	0.	0.	0.	7218.
Forest	13298.	6577.	11129.	928.	857459.	10619.	0.	4826.	1318.	789.	2872.	664.	910479.
Residential	0.	0.	0.	0.	0.	63108.	0.	0.	0.	170.	0.	0.	63278.
Urban idle	0.	0.	0.	0.	0.	509.	576.	0.	0.	0.	0.	0.	1085.
Transportation	0.	0.	0.	0.	0.	0.	0.	60389.	709.	0.	0.	0.	61098.
Recreation	0.	0.	0.	0.	0.	0.	0.	0.	4912.	0.	0.	0.	4912.
Comm.-Ind.-Inst. 1/	0.	0.	0.	0.	0.	0.	0.	0.	0.	9376.	0.	0.	9376.
Water bodies over 40 acres	0.	0.	2026.	0.	0.	696.	0.	0.	0.	0.	214305.	0.	217027.
Miscellaneous	4658.	696.	13020.	0.	1037.	1905.	0.	1291.	236.	232.	236.	122346.	145657.
1970 totals	343712.	150942.	400924.	9878.	931337.	125149.	576.	73913.	11693.	16529.	229906.	129195.	2423753.

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Appendix C table 15--Land use transition matrix for Group II, the NON SMSA county identified as an Urbanized Area

1961 land uses	1970 land uses												
	Cropland	Pasture and range	Open idle	Farm-steads	Forest	Residen-tial	Urban idle	Transpor-tation	Recrea-tion	Comm.- 1/ Ind.- Inst.	Water bodies	Miscel-laneous	1961 totals
	Acres												
Cropland	49153.	0.	7156.	0.	188.	3578.	0.	0.	0.	565.	0.	0.	60640.
Pasture and range	0.	753.	0.	0.	0.	377.	0.	0.	0.	0.	0.	0.	1130.
Open idle	565.	0.	19586.	0.	1883.	2072.	0.	565.	0.	377.	0.	0.	25048.
Farmsteads	0.	0.	0.	188.	0.	0.	0.	0.	0.	0.	0.	0.	188.
Forest	0.	0.	565.	0.	109041.	7910.	188.	377.	0.	188.	0.	0.	118269.
Residential	0.	0.	0.	0.	0.	46328.	0.	0.	0.	0.	0.	0.	46328.
Urban idle	0.	0.	0.	0.	0.	188.	1695.	565.	0.	377.	0.	0.	2825.
Transportation	0.	0.	0.	0.	0.	0.	0.	13748.	0.	0.	0.	0.	13748.
Recreation	0.	0.	0.	0.	0.	0.	0.	0.	3390.	0.	0.	0.	3390.
Comm.-Ind.-Inst. 1/	0.	0.	188.	0.	0.	0.	0.	0.	0.	12806.	0.	0.	12994.
Water bodies over 40 acres	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	22787.	0.	22787.
Miscellaneous	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	4332.	4332.
1970 totals	49718.	753.	27495.	188.	111112.	60453.	1883.	15255.	3390.	14313.	22787.	4332.	311679.

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Appendix C table 16--Land use transition matrix for Group III, SMSA counties including no Urbanized Area

1961 land uses	1970 land uses												
	Cropland	Pasture and range	Open idle	Farm-steads	Forest	Residen-tial	Urban idle	Transpor-tation	Recrea-tion	Comm.- 1/ Ind.- Inst.	Water bodies	Miscel-laneous	1961 totals
	Acres												
Cropland	184504.	1611.	9290.	0.	257.	7959.	0.	537.	561.	537.	0.	0.	205256.
Pasture and range	2661.	17959.	4576.	0.	257.	280.	0.	0.	0.	0.	0.	0.	25733.
Open idle	1306.	770.	27362.	0.	7446.	4505.	0.	537.	0.	1892.	0.	793.	44611.
Farmsteads	0.	0.	0.	7703.	0.	0.	0.	0.	0.	0.	0.	0.	7703.
Forest	0.	257.	793.	0.	384213.	257.	0.	1026.	537.	1050.	0.	0.	388133.
Residential	0.	0.	0.	0.	0.	19755.	0.	0.	0.	0.	0.	0.	19755.
Urban idle	0.	0.	0.	0.	0.	0.	561.	0.	0.	0.	0.	0.	561.
Transportation	0.	0.	0.	0.	0.	0.	0.	22851.	0.	0.	0.	0.	22851.
Recreation	0.	0.	0.	0.	0.	0.	0.	0.	793.	0.	0.	0.	793.
Comm.-Ind.-Inst. 1/	0.	0.	0.	0.	0.	0.	0.	0.	0.	4809.	0.	0.	4809.
Water bodies over 40 acres	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	6235.	0.	6235.
Miscellaneous	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	6998.	6998.
1970 totals	188471.	20597.	42021.	7703.	392173.	32756.	561.	24951.	1891.	8288.	6235.	7791.	733438.

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Appendix C table 17--Land use transition matrix for Group IV, SMSA counties containing Urbanized Areas but none of the central SMSA city

1961 land uses	1970 land uses												
	Cropland	Pasture and range	Open idle	Farm-steads	Forest	Residen-tial	Urban idle	Transpor-tation	Recrea-tion	Comm.- 1/ Ind.- Inst.	Water bodies	Miscel-laneous	1961 totals
	Acres												
Cropland	4034041.	50000.	181377.	987.	12992.	80860.	2106.	36624.	8843.	34086.	3020.	3043.	4456978.
Pasture and range	54849.	658245.	32714.	0.	4983.	3780.	0.	3932.	0.	1607.	190.	1220.	761520.
Open idle	53559.	46575.	668739.	235.	51601.	54857.	0.	8972.	4014.	28566.	6445.	3579.	927141.
Farmsteads	714.	0.	1129.	106474.	235.	645.	0.	348.	0.	1443.	0.	0.	110988.
Forest	6546.	2613.	28180.	432.	2427637.	43689.	403.	11220.	1419.	15017.	1878.	1008.	2540042.
Residential	0.	0.	642.	0.	216.	757781.	0.	1400.	0.	846.	0.	0.	760885.
Urban idle	0.	0.	0.	0.	0.	6528.	23918.	823.	413.	5788.	0.	0.	37470.
Transportation	0.	0.	0.	0.	0.	0.	0.	398542.	387.	0.	346.	0.	399275.
Recreation	0.	0.	0.	0.	0.	228.	0.	346.	60701.	0.	0.	0.	61275.
Comm.-Ind.-Inst. 1/	0.	0.	6517.	0.	0.	0.	0.	0.	0.	204512.	0.	173.	211202.
Water bodies over 40 acres	0.	0.	3982.	0.	434.	0.	0.	0.	248.	0.	233882.	0.	238546.
Miscellaneous	200.	0.	0.	0.	0.	0.	0.	669.	0.	0.	1841.	186305.	189015.
1970 totals	4149909.	764433.	923279.	108128.	2498098.	948368.	26427.	462876.	76025.	291865.	247602.	195328.	10694336.

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Appendix C table 18--Land use transition matrix for Group V, SMSA counties which include Urbanized Areas and part of the central SMSA city

1961 land uses	1970 land uses												
	Cropland	Pasture and range	Open idle	Farm-steads	Forest	Residen-tial	Urban idle	Transpor-tation	Recrea-tion	Comm.- 1/ Ind.- Inst.	Water bodies	Miscel-laneous	1961 totals
	Acres												
Cropland	617836.	19912.	67199.	509.	6869.	20240.	196.	2802.	0.	8565.	4446.	0.	748574.
Pasture and range	15153.	353191.	32795.	0.	3666.	1248.	0.	1530.	0.	2728.	1274.	196.	411771.
Open idle	5316.	2296.	163355.	196.	10179.	29937.	1851.	3269.	2757.	13537.	8641.	1322.	242656.
Farmsteads	0.	0.	656.	22716.	0.	0.	0.	231.	0.	231.	0.	0.	23834.
Forest	443.	2760.	9446.	0.	519403.	40232.	0.	4784.	0.	5482.	231.	316.	583097.
Residential	0.	0.	547.	0.	0.	327338.	0.	0.	0.	186.	0.	0.	328071.
Urban idle	0.	0.	0.	0.	0.	8396.	18940.	556.	556.	2936.	0.	0.	31384.
Transportation	0.	0.	0.	0.	0.	0.	0.	123840.	0.	0.	0.	0.	123840.
Recreation	0.	0.	0.	0.	0.	0.	0.	0.	20523.	0.	0.	0.	20523.
Comm.-Ind.-Inst. 1/	0.	0.	464.	0.	0.	0.	0.	0.	0.	91133.	0.	0.	91597.
Water bodies over 40 acres	0.	0.	637.	0.	0.	0.	0.	0.	0.	0.	64808.	0.	65445.
Miscellaneous	186.	0.	372.	0.	0.	316.	0.	0.	0.	0.	425.	41304.	42603.
1970 totals	638934.	378149.	275471.	23421.	540117.	427707.	20987.	137012.	23836.	124798.	79825.	43138.	2713393.

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Appendix C table 19--Land use transition matrix for Group VI, SMSA counties which include the entire central SMSA city

1961 land uses	1970 land uses												
	Cropland	Pasture and range	Open idle	Farm-steads	Forest	Residen-tial	Urban idle	Transpor-tation	Recrea-tion	Comm.- 1/ Ind.- Inst.	Water bodies	Miscel-laneous	1961 totals
	Acres												
Cropland	1220460.	19036.	66235.	0.	22332.	27831.	0.	3991.	3788.	10093.	681.	3166.	1377613.
Pasture and range	8602.	368390.	14898.	0.	3674.	3016.	0.	481.	589.	393.	0.	0.	400043.
Open idle	19553.	1704.	180765.	222.	42342.	25639.	0.	3528.	1962.	16798.	16070.	822.	309405.
Farmsteads	684.	196.	393.	41330.	0.	196.	0.	0.	0.	0.	0.	0.	42799.
Forest	6081.	1721.	23646.	210.	2010832.	40879.	891.	10643.	2307.	9493.	3784.	1507.	2111994.
Residential	0.	0.	0.	0.	0.	220809.	0.	739.	0.	393.	0.	0.	221941.
Urban idle	0.	0.	0.	0.	0.	1369.	3455.	0.	0.	2485.	0.	0.	7309.
Transportation	0.	0.	0.	0.	0.	0.	0.	159001.	0.	0.	0.	0.	159001.
Recreation	0.	0.	0.	0.	0.	0.	0.	0.	21336.	196.	0.	0.	21532.
Comm.-Ind.-Inst. 1/	0.	0.	909.	0.	0.	0.	0.	0.	0.	58045.	0.	0.	58954.
Water bodies over 40 acres	0.	0.	196.	0.	0.	0.	0.	0.	0.	0.	103401.	0.	103597.
Miscellaneous	210.	0.	432.	0.	0.	0.	0.	0.	0.	0.	393.	72696.	73731.
1970 totals	1255590.	391047.	287474.	41762.	2079180.	319739.	4346.	178383.	29982.	97896.	124329.	78191.	4887919.

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